EZ-TRAK

PROGRAMMING

AND

OPERATIONS MANUAL

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INTRODUCTION

The EZ-TRAK is an extension of the Bridgeport PCNC (PC-based Numeric Control) product line, providing the familiarity of a manual machine with the power of a CNC. The EZ-TRAK is specifically designed for the first-time PCNC user and is intended to bridge the gap between the hand-wheel driven milling machine and the full-featured PCNC, with the ease of use of one, and the increased productivity of the other.

The EZ-TRAK is targeted at milling one of a kind parts or small job lots and gives the user the flexibility of five different machines in one package:

- In the intelligent 3-AXIS DRO (digital readout) mode, the machinist can use the advanced digital readout and the axes handwheels in the same way that the conventional milling machines in the shop are operated.
- In the MDI (manual data input) mode, a step by step conversational display prompts the operator for all the information required to easily machine arcs, rectangles, circles, slots and bolt circles, etc.
- In the DO EVENT mode, the operator can switch between manual and automatic operation to make the part in a way that is the most convenient for the operator.
- In the TEACH mode the operator can manually machine the first part and save the coordinates of each move to replay the operations for subsequent parts.
- In the RUN mode, the EZ-TRAK can automatically run the same exact part programs used by thousands of other BRIDGEPORT CNCs.

The EZ-TRAK requires no prior knowledge of CNC programming, or machine tool experience. Following the on-screen prompts, and entering the requested information, the operator can begin cutting a part after only a few minutes of basic explanation on the machine operation. The programming environment in the EZ-TRAK intelligently prompts the user for basic part information found directly on a blueprint, and even provides math help functions for calculating necessary points.

About This Manual

This manual provides the necessary information to run and program the EZ-TRAK. It provides information via illustrations, and through a complete step-by-step tutorial which actually produces a part. For users with no previous experience on the EZ-TRAK, it is suggested that this manual be read in the following order for maximum clarity.

1) Chapter 1 - EZ-Trak Hardware
2) Appendix B - Axes and Coordinates
3) Chapter 2 - EZ-Trak Tutorial
4) Chapter 3 - Starting Up the EZ-Trak
5) Chapter 4 - Basic Operations

Changes from Rev. E:

Chapter 10: File Utilities contains ref. to Flashcard (Feb. 1997)

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CHAPTER 1
EZ-TRAK HARDWARE

This section discusses the EZ-TRAK hardware. For a more complete description of the EZ-TRAK's features and controls, refer to Chapter 8 in the *EZ-TRAK Maintenance and Installation Manual.*

The EZ-TRAK basic operation controls are described here as they are seen from the front of the machine looking from left to right. See Figure 1-1 below.

Figure 1-1

The operation controls listed here cover the basic functions and should be studied carefully before cutting any part on the EZ-TRAK.

OPERATOR'S CONTROL BOX

At the left of the spindle housing is the **Operator's Control Box**. There are five controls on this box. These have the following functions.

COOLANT FLOOD- OFF- MIST. This three way switch activates the flood or spray mist coolant functions.

SPINDLE LOW GEAR- OFF- HIGH GEAR. This three way switch is used to set the direction of the spindle and to shut the spindle OFF. This switch should be set the same as the **SPEED RANGE** selector at the lower right side of the spindle housing to set the clockwise direction of rotation (e.g. Set the SPEED RANGE selector to HIGH, and the three position switch on the operator's control box to HIGH GEAR, to make the spindle rotate in the clockwise direction).

SPINDLE START. This indicator push button starts the spindle providing the SPINDLE selector switch is not set to OFF.

WARNING: ENSURE THE GREEN LIGHT IS ON (SPINDLE POWER OFF) BEFORE CHANGING TOOLS.

EMERGENCY STOP. This red mushroom switch is used to shut down all power to the spindle and axis drives in the event of an emergency. When the E-Stop button is pressed, the computer screen displays an ALARM condition in the top left corner of the screen. To clear the alarm condition, pull out the EMERGENCY STOP button then follow the instructions on the screen to continue.

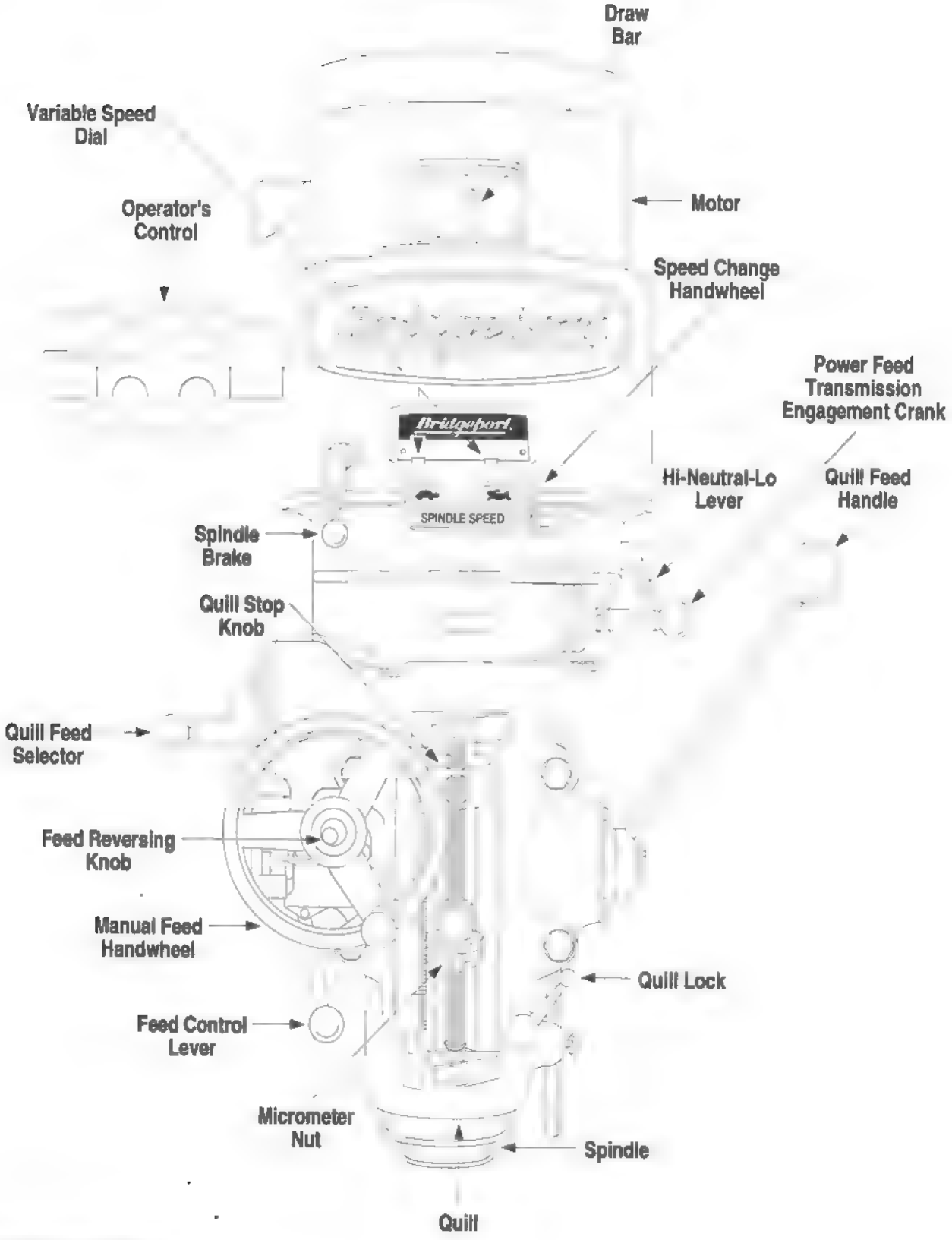
DO NOT RESTART THE EZ-TRAK BEFORE PULLING OUT THE EMERGENCY STOP BUTTON.

REMOTE START SWITCH. This is a hand held switch attached to a flexible cord at the left side of the operator's control box. It can be used in place of the **START** button on the EZ-TRAK keyboard when the operator is prompted to press the **START** button.

OTHER CONTROLS

There are two other important controls that are used in basic operation of the EZ-TRAK. At the lower right side of the spindle housing is the **SPEED RANGE** selector for the spindle motor This selector has three positions for setting the gearing of the spindle motor. These are LOW, NEUTRAL, and HIGH. Be certain to check the position of this selector when starting up the EZ-TRAK. **WARNING: Do not attempt to change the SPEED RANGE setting while the spindle is in motion.**

Figure 1-2


Draw Bar
Variable Speed Dial
Operator's Control
Motor
Speed Change Handwheel
Power Feed Transmission Engagement Crank
Bridgeport
SPINDLE SPEED
Hi-Neutral-Lo Lever
Quill Feed Handle
Spindle Brake
Quill Stop Knob
Quill Feed Selector
Feed Reversing Knob
Manual Feed Handwheel
Quill Lock
Feed Control Lever
Micrometer Nut
Spindle
Quill

To the right of the operator's control box, on the spindle housing itself, is a short black knob. This is the **SPINDLE BRAKE** knob. When the spindle is shut **off** (the green light on the operator's control box is **on**) this knob can be used to slow the spindle to a stop. Rotate this handle back towards the rear of the machine, or forwards toward the front of the machine to brake the spindle to a stop.

For the explanation and operation of the controls shown in Figure 1-2, please refer to Chapter 8, **Controls Operation**, in the *Installation, Operation, Maintenance, and Parts Breakdown Manual* (code no. 11043163).

CRT FRONT PANEL

Additional controls located on the CRT FRONT PANEL are:

HOLD	This interrupts automatic operation. The **START** command will resume operation.
JOG SWITCH **JOG ROTARY KNOB**	In the JOG mode these two controls are used to position the table by moving the X and Y axes separately.

EZ-TRAK COMPUTER HARDWARE

For detailed descriptions of the EZ-TRAK SX and DX computer hardware, see Appendix A System Overview at the back of this manual. Also, refer to the *Installation, Operation, Maintenance, and Parts Breakdown Manual* (code no. 11043163) for more details.

WARNING:

The EZ-TRAK screen is subject to phosphor burn-in, a condition which often occurs on CRT (Cathode Ray Tube) screens when they display the same information for long periods of time. To prevent the screen from becoming damaged in this manner it is important that you turn down the screen intensity, especially when the machine is not in use for periods of more than a few minutes. This will extend the life of the computer screen by a great deal. The brightness intensity control is just beneath the lower edge of the computer screen, towards the right side. A screen saver will aid in the prevention of phosphor burn-in. This screen savor will activate automatically after three (3) minutes of non-use of the machine.

KEEP THE SCREEN INTENSITY LOW

CHAPTER 2
EZ-TRAK TUTORIAL

Introduction

This section of the manual describes in detail, the basic operation of the machine, by means of a step-by-step tutorial. It is a good idea to read through this section of the manual first, before beginning any operation on the EZ-TRAK.

Cutting a Part on the EZ-TRAK

This tutorial describes cutting a simple part on the EZ-TRAK using the **DO EVENT** mode to execute instructions one at a time. Each programmed event is given in this tutorial with a brief explanation. This tutorial assumes that you have already read the previous descriptions in this section and are familiar with the basic operation of the EZ-TRAK.

This tutorial also assumes that you have some experience operating a manual turret mill, or you are at least familiar with the operation of one.

The blueprint for the part you are going to cut is shown below in Figure 2-1.

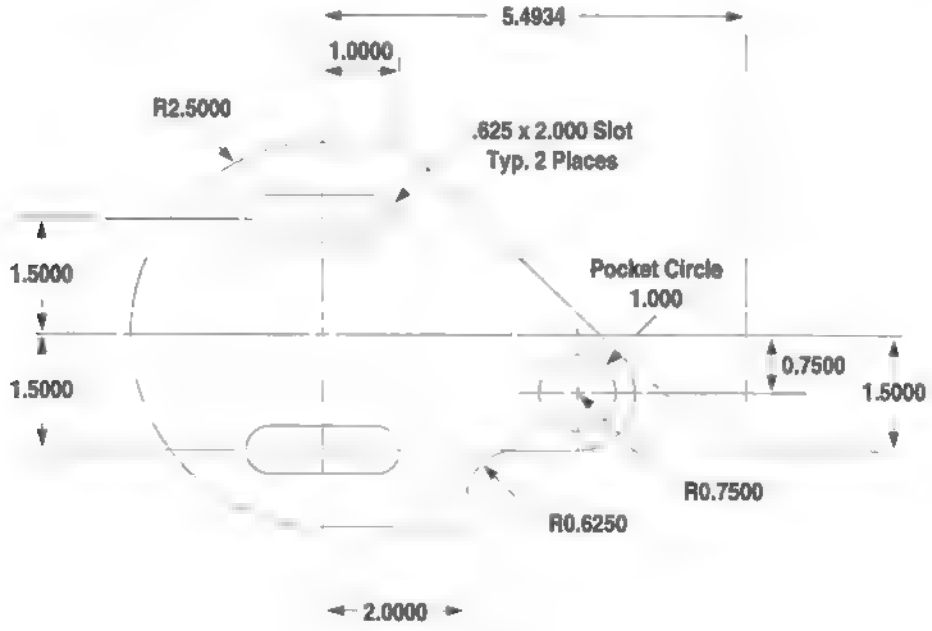


Figure 2-1

Under normal conditions, this part would not be cut using the DO EVENT mode. Instead, a part program to cut this part would be written using the **MDI** mode, and then executed using the **RUN** mode. However, to demonstrate the EZ-TRAK and use of the machining commands, we will step through cutting this part one instruction at a time.

The part origin is placed at the center of the large 180° arc on the left side of the part. The starting point for cutting this part is at the bottom of this arc. The contour of this part is cut with eight instructions, as shown in Figure 2-2 at the right. The three pockets each require one positioning move, and one machining instruction. The coordinates which are entered for the instructions in this tutorial have been calculated to allow for a **0.125** tool offset for a **0.25** inch endmill.

It is highly recommended that you read through this tutorial completely before attempting to cut this part on the EZ-TRAK.

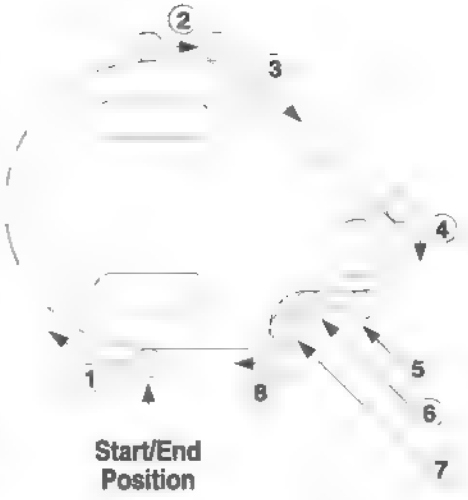


Figure 2-2

Beginning the part

1. Turn on the EZ-TRAK. Do this by turning the MAIN DISCONNECT on the cabinet at the back of the machine to the **ON** position.

2. Home the axes by pressing the **3** key (**MOV ABS**) on the operator's keyboard.

3. Press the **+** key to execute the **HOME AXES** routine.

4. The **MOV ABS** screen is displayed automatically after the axis homing routine is executed (because the **MOV ABS** key was pressed to initiate the homing sequence).

5. Enter **0.000** for X, and **0.000** for Y and then press **Enter**. This moves the axes to the center of the work table.

6. Based on the blueprint in Figure 2-1, select your work material and cutter (the part measures 6.8" x 5" and is cut at a 0.25" depth). The cutter should be a 0.25" endmill.

7. Secure the work material to the worktable so that the piece is approximately centered under the current tool position.

8. Insert your cutter into the quill, and secure it.

9. Press the **7** key (**SET XYZ**) on the operator's keyboard. With the spindle **off**, move the quill down so that the tool touches the top of the work material. This point is set as zero (0.0000) in the Z axis. Enter **0.0000** for each of the X, Y, and Z coordinates.

Cutting the Contour

1. The starting point is at the bottom of the part and the tool path goes clockwise around the part. The instructions given here do not make use of the cutter compensation feature of the EZ-TRAK; the numbers in this program have been adjusted for a 0.25" endmill.

2. Move the quill up so that the tool is clear of the workpiece. Press the **2** key (**DO EVENT**) on the operator's keyboard.

3. Press the **1** (**POS/DR**) key, and enter **0** for a positioning move. Enter **0.0** for the **X ABS** value, and **-2.625** for the **Y ABS** value, and **0.500** for the **Z** value and press **Enter**. The screen shows:

```
>>CHECK Z

0000 RAPID ABS X0.0 Y-2.625 Z0.500
```

   Press the + key to execute the rapid positioning move to the new location.

4. Start the spindle, turn the coolant **On**, and move the quill down into the workpiece to the 0.25" depth. The Z coordinate should now read **-0.2500**.

5. ① Press the **3** (**M ARC**) key. Enter **2** for clockwise. Enter **0.0** for the **X ABS** value. Enter **2.625** for the **Y ABS** value. Enter **-0.25** for the **Z** value. Enter **0.0** for the **[X arc cntr** value and **0.0** for the **Y arc cntr]** value. Be sure to leave the **Radius** field blank. Enter **10.** for the **Feed** value. The screen shows:

```
>>CHECK Z

0010 ARC|CNTRPT ABS CW X0.0 Y2.625 Z-0.25 XC0.0 YC0.0 F10.
```

   Press the + key to execute the mill arc move.

6. ② Press the **2** (**M LINE**) key. Enter **1.0476** for the **X** value. Enter **2.625** for the **Y** value, and **-0.25** for the **Z** value. Enter **10.** for the **Feed** value. The screen shows:

```
>>CHECK Z

0020 LINE ABS X1.0476 Y2.625 Z-0.25 F10.
```

   Press the + key to execute the mill line move.

7. ③ Press the **2** (**M LINE**) key. Enter **4.1047** for the **X** value. Enter **-0.0964** for the **Y** value, and **-0.25** for the **Z** value. Enter **10.** for the **Feed**. The screen shows:

```
>>CHECK Z

0030 LINE ABS X4.1047 Y-0.0964 Z-0.25 F10.
```

   Press the + key to execute the mill line move.

8. ④ Press the **3** (**M ARC**) key. Press the **F4** key to select the program radius screen. Enter **2** for clockwise. Enter **3.5229** for the **X ABS** value. Enter **-1.625** for the **Y ABS** value, and **-0.25** for the **Z** value. Enter **0.875** for the **Radius** value. Enter **10.** for the **Feed** value. The screen shows:

```
>>CHECK Z

0040 ARC|RADIUS ABS CW X3.5229 Y-1.625 Z-0.25 R0.875 F10.
```

Press the + key to execute the mill arc move.

9. ⑤ Press the **2** (**M LINE**) key. Enter **2.625** for the **X** value. Enter **-1.625** for the **Y** value, and **-0.25** for the **Z** value. Enter **10.** for the **Feed** value. The screen shows:

```
>>CHECK Z

0050 LINE ABS X2.625 Y0.0 Z-0.25 F10.
```

Press the + key to execute the mill line move.

10. ⑥ Press the **3** (**M ARC**) key. Enter **3** for counter-clockwise. Enter **2.125** for the **X ABS** value. Enter **-2.125** for the **Y ABS** value, and **-0.25** for the **Z** value. Enter **2.625** for the **[X arc cntr** value and **-2.125** for the **Y arc cntr]** value. Enter **10.** for the **Feed** value. The screen shows:

```
>>CHECK Z

0060 ARC|CNTRPT CCW X2.125 Y-2.125 Z-0.25 XC2.625 YC-2.125 F10.
```

Press the + key to execute the mill arc move.

11. ⑦ Press the **2** (**M LINE**) key. Enter **2.125** for the **X** value. Enter **-2.625** for the **Y** value, and **-0.25** for the **Z** value. Enter **10.** for the **Feed** value. The screen shows:

```
>>CHECK Z

0070 LINE ABS X2.125 Y-2.625 Z-0.25 F10.
```

Press the + key to execute the mill line move.

12. ⑧ Press the **2** (**M LINE**) key. Enter **0.0** for the **X** value. Enter **-2.625** for the **Y** value, and **-0.25** for the **Z** value. Enter **10.** for the **Feed** value. The screen shows:

```
>>CHECK Z

0080 LINE ABS X0.0 Y-2.625 Z-0.25 F10.
```

Press the + key to execute the mill line move.

The contour of the part is now complete. Move the tool up out of the part.

Cutting the Slots

Now the two slots and the circular pocket must be cut. These are cut at the same depth using the same tool.

1. Press the **.** (**M SLOT**) key. Enter **0.25** for the **tool diameter** value. Enter **-0.6875** for the **X** value. Enter **1.5** for the **Y** value. Enter **-0.25** for the **Z** value. Enter **2.0** for the **out to out** value. Enter **0.625** for the **width** of the slot. Enter **0** for the rotation angle. The screen shows:

```
>>CHECK Z

0090 SLOT X-0.6875 Y1.5 Z-0.25 P2.0 P0.625 P0 D0.25 F10.
```

   Press the **+** key to execute the slot mill move.

2. When the slot is cut, move the tool out of the part.

3. Press the **1** (**POS/DR**) key, and enter **0** for X, **-1.5** for Y and **0.5** for **Z**. Press **Enter**. The screen shows:

```
>>CHECK Z

0100 RAPID ABS X0.0 Y-1.5 Z0.5
```

   Press the **+** key to execute the positioning move.

4. Press the **.** (**M SLOT**) key. Enter **0.25** for the **tool diameter** value. Enter **-0.6875** for the **X** value. Enter **-1.5** for the **Y** value. Enter **-0.25** for the **Z** value. Enter **2.0** for the **out to out** value. Enter **0.625** for the **width** of the slot. Enter **0** for the rotation angle. The screen shows:

```
>>CHECK Z

0110 SLOT X-0.6875 Y-1.5 Z-0.25 P2.0 P0.625 P0 D0.25 F10.
```

   Press the **+** key to execute the slot mill move.

5. When the slot is cut, move the tool out of the part.

Cutting the Circular Pocket

Press the **M CIRC** key. Press the **F4** key to create a circular pocket. Enter **0.125** for the **PKT stepover**. Enter **0.25** for the tool diameter. Enter **3.5229** for the **X** value, and **-0.75** for the **Y** value. Enter **-0.25** for the **Z** value. Enter **0.5** for the **radius** value. Enter **0.25** for the **approach** value. Enter **0.01** for the **allowance** value. Enter **10.0** for the **F Rough** value, and **15.0** for the **F Finish** value. The screen shows:

```
>>CHECK Z

0120 CIRCLE PKT X3.5229 Y-.75 Z-.25 R.5 P.25 P.01 P.125 D.25 F10. F15.
```

Press the **+** key to execute the circular pocket move.

The part is now complete. Press **0** (**EXIT**) to leave the **DO EVENT** mode.

CHAPTER 3
STARTING UP THE EZ-TRAK

Introduction

This chapter discusses starting up the EZ-TRAK and using the basic commands to control the movement of the worktable. It is important to read through this chapter before cutting any part on the EZ-TRAK.

Before Starting the EZ-TRAK SX

The EZ-TRAK SX loads a special program into the memory of the computer as soon as the power switch at the back of the cabinet is turned on. This program is stored on a 3.5" diskette labelled **EZ-TRAK SX**. Before turning on the power, find this diskette. Read Appendix A in this manual for more information about the System Disk.

Walk around to the back panel of the machine, and find a black sliding panel near the top of the cabinet. Inside this panel is the disk drive for the computer. Take the EZ-TRAK SX diskette, and put it carefully into the slot, with the label of the diskette facing to the right. Push it into the disk drive until it clicks into place.

If the disk stops and it won't go any further into the drive, check to see if there is a disk in the drive already, by pushing the eject button on the drive (the **eject** button is a small button on the drive itself, inside the sliding door). If no disk is in the drive, be sure that the label is on the right and push the disk into the drive again. Once the disk is in the disk drive, close the sliding panel over the drive, so that nothing can interfere with the disk operation.

Turning on the EZ-TRAK

On the back panel of the machine is a large handle. This is the power switch (main disconnect) for the machine. It turns on power to the computer as well as the drive motors and spindle motor. The **EZ-TRAK SX** diskette **must** be in the disk drive **before** turning on the power. EZ-TRAK DX does not require a diskette in the floppy drive before turning on the power.

Turn the power handle to the **on** position shown by the arrow. You will feel a solid click when the power is turned on. Walk back around to the front of the machine.
Note: it is not a good idea for anyone to remain behind the machine while it is in operation.

As the computer starts up, you will see various messages flash across the CRT display on the operator's panel. These messages are mostly unimportant. When full power is reached, the screen shown in Figure 3-1 is displayed.

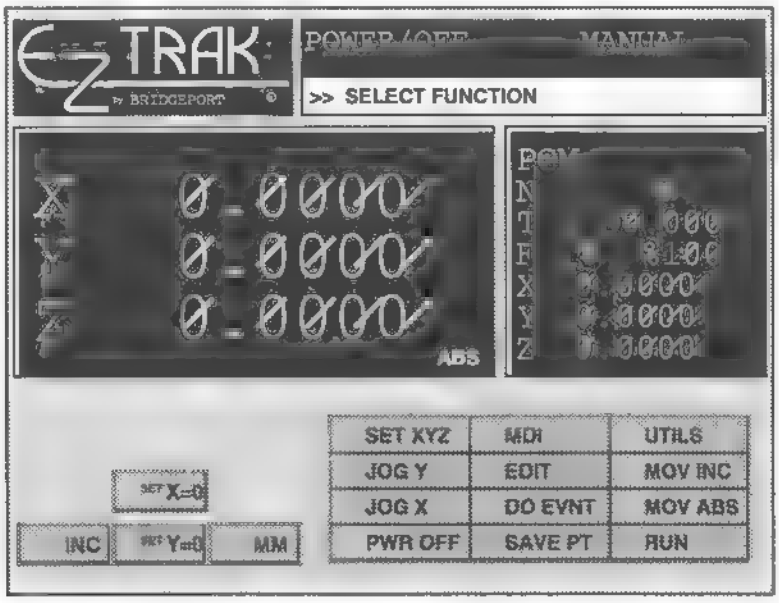


Figure 3-1

Look first at the top left of the screen and note that the message reads **EZ-TRAK NOT HOMED. PRESS MOV ABS**. This means that the EZ-TRAK must go through the process of homing the axes before the machine is ready to operate. Read the section below titled **Homing the Axes** before continuing.

Homing the Axes

The EZ-TRAK needs to find the limits of the worktable travel each time the machine is turned on. This process is called **homing the axes**.

Homing the axes takes place when power is first applied to the X and Y drive motors after starting the machine. Note that the EZ-TRAK always starts up in the POWER/OFF mode.

FOR SAFETY: Fold up the handles on the handwheels at the front and right side of the machine. It can be dangerous to leave these unfolded while the machine is running in automatic mode.

Look at the screen again. At the lower right side is a pattern of buttons that represent the operator's keyboard. These buttons show what function each button has at any one moment. Right now, the **3** key on the keypad has the function **MOV ABS**. Press this key to apply power to the axis drive motors, and home the axes, by pressing the **+** key.

The table immediately begins to move to the front and to the left. When the trip-switches beneath the table are set, the table stops moving, and the limits of the table are set. This also resets the X and Y coordinates, so that the last saved origin is active.

Since the **MOV ABS** (move absolute) key was pressed to home the axes, the CRT now displays the **MOV ABS** screen. Press **0** then **Enter** for each of the X Y and Z coordinates. The screen shows the message **SET Z @ 0.000** and **MOVE ABS X Y0.000**. Press the + key to execute the move to the **0,0** point. The table moves, and the screen returns to the BASIC OPERATIONS screen.

Jogging the Axes

From the BASIC OPERATIONS screen, the **JOG** menu can be shown by pressing either the **1 JOG X** or **4 JOG Y** keys. Press the **1 JOG X** key now.

To **jog** the axes means that the X and Y axes can be selected separately and can be moved by using any of three different controls on the operator's panel. The first is the **JOG SWITCH**, the second is the rotary **JOG KNOB**, and third are the **STEP** + and – keys on the keyboard.

In this case the **JOG X** button was pressed so that only the **X** axis can be jogged. Turn the jog switch so that the arrow points towards the – sign. Press the button and hold it firmly to jog the X axis. Release the button after jogging the axis several inches.

The + and – keys on the keyboard are **FEED OVERRIDE** keys. They are used to change the rate at which the table moves when the **JOG SWITCH** is pressed. Press the – key to slow down the jog rate, then press the jog switch.

Press the **JOG Y** key on the keyboard. Using the **jog switch**, jog the tool several inches in the – direction. The jog direction can be changed by turning the **jog switch** towards the + sign. Jog the Y axis back towards the center.

After jogging the Y axis back to the center, try jogging the axis by using the **rotary jog knob**. The jog knob moves the axis 0.1000" for every full rotation (360°) of the knob .

Also try pressing the **STEP+** and **STEP–** keys. These keys jog the axes 0.0005" each time the key is pressed. Press the **0 EXIT** key to exit the **JOG** mode.

Manual Movement

Press the **0 PWR OFF** key to turn off the power to the axis drives. Look at the top center portion of the screen. The message should now read **POWER / OFF MANUAL**. This is the **Manual** mode. This means that the table can now be moved by turning the handwheels at the front and right side of the worktable.

Fold down the handles on the handwheels and try moving the worktable in each direction. Note that the large display numerals showing the X Y and Z coordinates of the tool change as you move the handwheels. The X coordinate changes as you move the handwheel at the right side of the table, and the Y coordinate changes as you move the handwheel at the front of the worktable.

Note that when you reverse direction using the handwheels, the axes coordinates are not immediately updated. This occurs because the system must compensate for the backlash which is set as one of the system parameters.

The Z Axis

The EZ-TRAK has motor drives on the X and Y axes. The Z axis, must be set by manually pulling a handle which lowers the tool quill. The software is designed to tell the operator when to lower the quill and how far it should be lowered.

When a change in depth is required during a part program, the operator is prompted to move the tool, and is also given the new position of the tool. When the Z axis readout is the same as the small Z coordinate at the right side of the screen, then the tool is properly positioned.

Reading the CRT Display

The EZ-TRAK uses a Cathode Ray Tube (CRT) to display most of the necessary operating information. This is the screen located next to the keyboard. Learning to read this display quickly and accurately will make using the EZ-TRAK much easier.

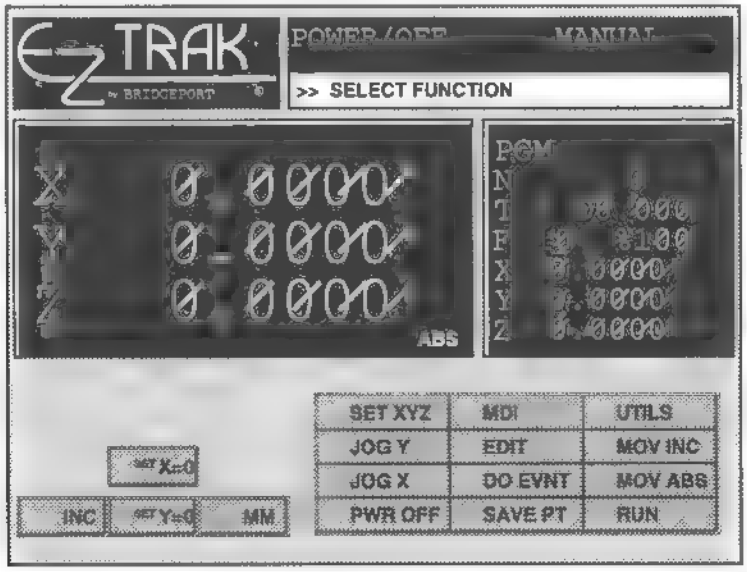


Figure 3-2

The screen shown in Figure 3-2 is the basic screen displayed when the EZ-TRAK is first powered up. The XYZ coordinates have already been discussed at length. Down in the lower right corner of the large XYZ display is the indicator for either **Absolute** or **Incremental** mode. This indicator is either given as **ABS** or **INC**. The screen shown above is in **Absolute** mode. When in **Incremental** mode, the left arrow cursor key has the function of shifting to **Absolute** mode, as shown above. When the EZ-TRAK is in **Absolute** mode the same key has the function of shifting to **Incremental** mode.

When the power switch at the back of the machine is turned on, the EZ-TRAK defaults to the **Absolute** mode.

To the right of the large XYZ display is a smaller box with a similar set of XYZ coordinates at the bottom. This area gives the operator several important pieces of information.

PGM This gives the program number that is currently being run. If no program is loaded into memory currently this area is blank.

N This shows what line number the EZ-TRAK SX is currently executing. If no program is being executed this area also appears blank.

T The tool number that is currently called for in the part program is shown here. The operator is prompted to change the tool when it is necessary.

D The programmed diameter of the current tool is shown here.

F This shows the current feed rate. This value can be overridden by using the feedrate override keys.

% The override percentage of the programmed feedrate is shown here. If the feedrate has been increased using the feedrate override keys, the percentage shown here is greater than 100%. If the feedrate has been decreased using the override keys, the percent shown here is less than 100%.

X The X coordinate of the target point (the point the machine is moving towards) is shown here.

Y The Y coordinate of the target point is shown here.

Z The Z coordinate shown here gives the tool depth required at the target point. When a change in cutting depth is required, the operator is prompted to adjust the Z axis, and the programmed depth is shown here. The Z axis should be adjusted until the large Z coordinate is shown the same as shown here.

At the top of the screen, next to the EZ-TRAK logo, the power condition of the axis motor drives is shown in large letters. **POWER/ON** means that the axis drives are currently under power and cannot be adjusted by turning the handwheels. The axes can be jogged using the **JOG X** and **JOG Y** commands, or moved by means of the **MOVE ABS** or **MOVE INC** commands. When the **POWER/OFF** condition is shown, then the axes can be moved with the handwheels. POWER/OFF does **not** mean that power to the spindle or control computer is off. The EZ-TRAK defaults to the **POWER/OFF** condition when the power switch at the back of the machine is first turned on.

Directly to the right of the axis power condition is the operational mode display. In Figure 3-2, the **MANUAL** mode is shown. In the **DO EVENT** mode this area shows **OPER CMD** to show that the machine is ready for the operator's command. When a program is running, this display shows **SET: RUN** to indicate that the program is set and is in the **RUN** mode.

The lower half of the display shows the operator's keyboard and the functions of the keys on the keyboard. The keys shown on the screen appear in the same way that they are arranged on the keyboard The functions of the keys will change when the machine changes from one mode to another. It is important to pay close attention to the functions of the keys as they are shown on the screen.

Figure 3-3

Figure 3-3 shows the keyboard as it is shown on the EZ-TRAK's start-up screen (see Figure 3-2). The key functions shown here are different from the key functions shown in the DO EVENT mode, or the EDIT mode. Each of the chapters in this manual shows and describes the appropriate key functions in detail. For an explanation of the keys shown in Figure 3-3, see chapter 4, BASIC OPERATIONS.

CHAPTER 4
BASIC CONTROLS AND OPERATION

Basic operation of the EZ-TRAK is controlled from the front panel on the right side of the EZ-TRAK, and from the operator's control box on the left of the spindle housing.

The front panel includes a CRT (Cathode Ray Tube) display for the computer functions of the EZ-TRAK, a keyboard from which commands are given, and three controls to the left of the computer screen.

The computer screen shows the operator all of the information necessary to run the EZ-TRAK. This includes details such as tool location and diameter, feedrate, and program information.

The keyboard on this panel is used to enter commands to the EZ-TRAK. Each key is assigned a command or function, which is shown on the screen. The function of each key may change as the mode of operation changes. The CRT displays which keys can be used in each mode, and the function of each.

BASIC OPERATION

When power to the EZ-TRAK is turned on the BASIC OPERATIONS screen is displayed.

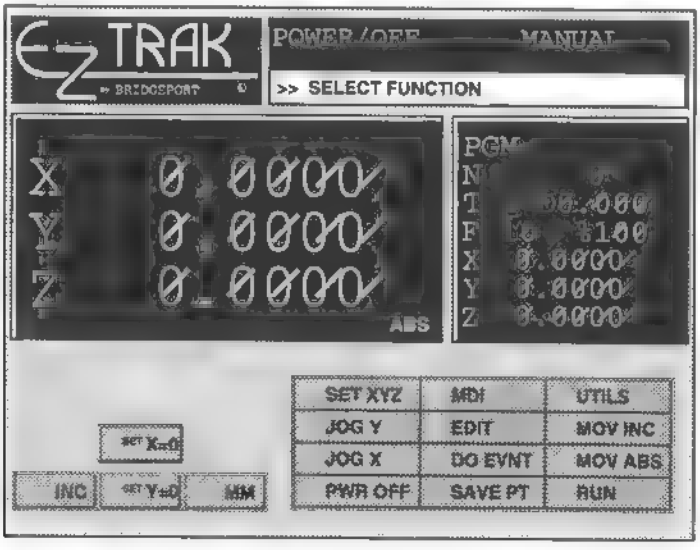


Figure 4-1

From this screen you can access all of the other modes of the EZ-TRAK. The screen displays all of the keys on the keyboard, and shows the function of each. These are explained in detail below.

To execute a command, one of the keys on the front panel must be pressed. The front panel keys used by the EZ-TRAK include numeric keys **<0 – 9>**, math operator keys **<+ – * />**, cursor keys **<up,down,left,right>**, **<ESC>**, **<ENTER>** and **<BACKSPACE>**. Note that the function of each key may change depending on the mode of operation of the EZ-TRAK.

The key functions shown in the BASIC OPERATIONS screen are:

0 **PWR OFF**. This will remove power from the drives to enable manual operation. In the MANUAL mode the readout will display position to the nearest .0001". In the POWER ON mode the large XYZ readout will display actual position and the small XYZ readout will display the target position.

1 **JOG X**. (also **4 JOG Y**) This command is used to move the X axis, by pressing the **JOG BUTTON** or by using the **JOG KNOB**. Selecting **JOG X** (or **JOG Y**) will turn POWER ON if it is OFF, and call up the JOG SCREEN. Use this command (instead of the MOVE commands) to move the X axis and Y axis separately, or if the coordinates of the desired position are not known (e.g. You want to move the tool to the left side of the part instead of the right side). See Chapter 5 in this manual.

2 **DO EVENT**. This command calls up the DO EVENT screen which allows the machine to execute programmed instructions one at a time. This command will also turn POWER ON if it is OFF. See Chapter 6 DO EVENT in this manual.

3 **MOV ABS** (also **6 MOV INC**) This command moves the tool to a new point. The coordinates of the new point must be entered on the screen before the tool is moved. This command will also turn POWER ON if it is OFF. Use this command (instead of the JOG command) to move the X and Y axes at the same time to a position where the X and Y coordinates are known. The **MOV ABS** command is also used to **HOME THE AXES** if this has not been done already.

The X,Y,Z coordinate values can be entered directly, or the **POLAR** or **CALC** sub commands can be used . Each of these two commands makes the system calculate the X,Y,Z coordinates based on other data entered at the keyboard.

CALC

The **CALC** command can be used to enter and evaluate mathematical equations so that points can be calculated. Trigonometric functions, square roots, and exponential functions can be used in the entered equations. See Appendix B at the back of this manual for more information on using the calculator.

POLAR

Using the **POLAR** command, the system will convert entered **polar** coordinates into XY coordinates. When the **/POLAR** key is pressed, the screen prompts the user for the following values.

R This is the radius value. Either a positive or negative value can be entered.

A This is the angle value. Either a positive or negative value can be entered.

XC This is the X coordinate of the pole.

YC This is the Y coordinate of the pole.

The system will calculate and then fill in the transformed X and Y values, when **Enter** is pressed after all of the fields are filled.

4 **JOG Y**. This command jogs the Y axis. See the **1 JOG X** command.

5 **EDIT**. This command enables editing a previously created PGM. See the section titled **Editor** for descriptions of how the editor is used.

6 **MOV INC**. This command is used to move the X and Y axes incrementally. See the **3 MOV ABS** command.

7 **SET XYZ**. This key enables the operator to place the PART PROGRAM coordinate system with respect to the current position of the table.

The operator enters the values to be set as the PARTPROGRAM coordinates for the current table position. For example, if the axes have just been homed and the PARTPROGRAM 0,0 is the center of travel, you would enter X 15. Y 6. This sets the current position as 15,6.

NOTE: The HOME position is the extreme +X,+Y machine travel position as set by the combination of a travel limit switch and a marker on the motor feedback encoders. For the EZ-TRAK maximum travel is X 30, Y 12.

The **CALC** and **POLAR** commands can also be used in the **SET XYZ** command.

8 **MDI** provides the ability to create PARTPROGRAMs. See Chapter 7 titled **MDI PROGRAMMING** for more information on using the **MDI** mode.

9 **UTILS** The **9** key in the BASIC OPERATIONS screen temporarily exits the EZ-TRAK environment to allow the user to run several disk utility programs which are used to copy programs, copy disks, and manage files. A utility is also provided for sending and receiving files from a remote computer. For more information on the file utilities, see Chapter 10.

<cursor LEFT> ABS-INC. This changes the context of the XYZ readout from **incremental** to **absolute**. The current mode is indicated at the lower right corner of the XYZ readout with an abbreviation either **ABS** or **INC**.

<cursor RIGHT> INCH-MM. This switches the system from INCH to METRIC. The current measurement mode is indicated by the position of the decimal point in the XYZ display. If three decimal places are shown, the mode is metric. Four decimal places are shown in inch mode. The EZ-TRAK has the ability to save the work mode when the machine is shut down. If the machine is shut down in the INCH mode, it will boot up in the INCH mode, if it is shut down in the METRIC mode it will boot up in the METRIC mode.

<cursor UP> set X=0 <cursor DOWN> set Y=0. These commands reset the X and Y coordinates to 0. In the absolute mode (**ABS**), this resets the part program origin. In the incremental mode (**INC**) this sets a local coordinate zero point.

<.> SAVE PT. This enables the operator to select up to 100 XYZ points, which are stored in the system. The points can then be replayed to replicate the same sequence of moves the operator originally went through to machine the part. For more information on the **TEACH** mode and the **SAVE PT** command see Chapter 11 **TEACH MODE** in this manual.

+ RUN. The + key in the BASIC OPERATIONS screen calls the **RUN** mode. For more information on the **RUN** mode see chapter 9 **RUN MODE** in this manual.

CHAPTER 5
MANUAL DRO and JOG OPERATION

INTRODUCTION

When power to the axis drives is turned OFF, the display shows the **MANUAL** mode in the upper right hand corner of the screen. In this mode, the EZ-TRAK operates as a sophisticated three axis manual machine with a digital readout.

MANUAL DRO and JOG OPERATION

To remove power from the axis drives press the **0 PWR OFF** command in the BASIC OPERATION screen. NOTE: POWER is only removed from the axis drives. The EZ-TRAK retains all system software, part-programs and position information.

There are two modes of MANUAL operation:

1. **ABS**. In the ABSOLUTE mode the XYZ readout displays the distance from the part program origin. To set the part program origin press the **7 SET XYZ** key. To select the ABSOLUTE mode use the **<left arrow>** key that toggles between ABSOLUTE and INCREMENTAL mode. Selecting the ABSOLUTE mode will restore the previous SET value for the part program origin.

2. **INC**. In the INCREMENTAL mode the XYZ readout will display the distance from the last local setpoint. To SET a local setpoint use the **<up arrow> XRES** command or the **<down arrow> YRES** command. The designated incremental position register will be zeroed. The local incremental position register will also be zeroed when the SET XYZ command is used.

The **ABS** or **INC** mode is indicated by the three letter abbreviation shown below and to the right of the large XYZ coordinate display on the screen.

IN to MM or MM to IN

Use the **<left arrow> MM IN** key to toggle between inch and metric. The position of the decimal point (4 places for inch, three places for metric) indicates the active system (Standard or Metric).

USING THE SAVE POINTS COMMAND

While the EZ-TRAK is in the **MANUAL** mode, and a part is being cut by hand, the **SAVE POINTS** command can be used to "**TEACH**" the EZ-TRAK to cut the same part.

At each significant point in the manual machining operation, a point can be saved as a **MILL EVENT** or as a **DRILL EVENT**. The EZ-TRAK records each point and the event type. Up to 100 points can be stored. At the end of the machining process, the points can be replayed, to duplicate the manual machining operation. The file in which the points are stored, named TEACH.PGM, can also be edited in case errors are made, or in case changes are needed.

See Chapter 11 in this manual for more information on using the **TEACH** mode.

JOG

The JOG command can be used to move the table to a designated position, to continuously move the table at the set feedrate if the JOG selector switch is depressed or to move the table synchronous with operation of the JOG ROTARY KNOB.
Use the **1 JOG X** or **4 JOG Y** commands in the BASIC OPERATIONS screen to select the JOG MODE.

The JOG command will turn POWER to the drives ON if it is OFF, call up the HOMING routine if the system has not been HOMED and then call up the JOG screen.

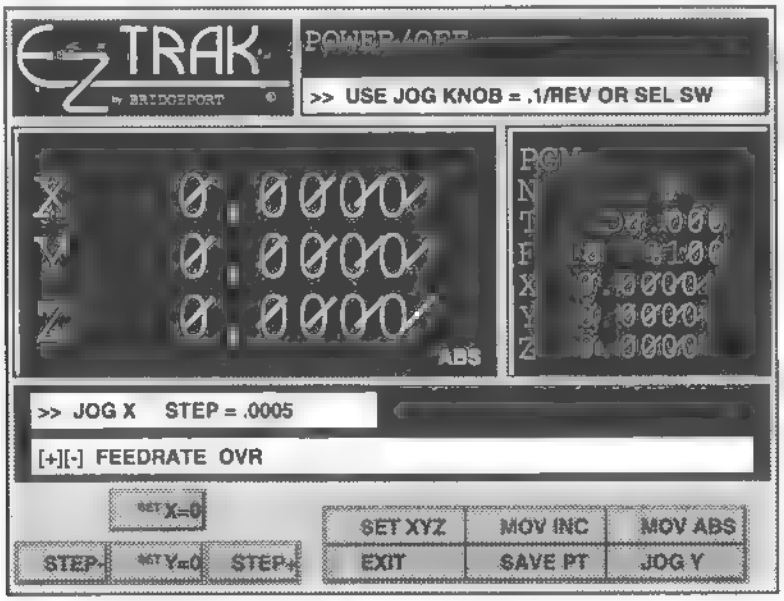


Figure 5-1

<left arrow> STEP –

Pressing this key in **JOG** mode will jog the axis (either X or Y) by **–0.0005** inches. This key always jogs the axis in the negative direction.

<right arrow> STEP +

Pressing this key in **JOG** mode will jog the axis (either X or Y) by **+0.0005** inches. This key always jogs the axis in the positive direction.

<up arrow> XRES

Pressing this key in the **JOG** mode resets the X coordinate to zero.

<down arrow> YRES

Pressing this key in the **JOG** mode resets the Y coordinate to zero.

0 EXIT

Pressing the **0** key exits the **JOG** mode and returns to the BASIC OPERATIONS screen.

1 SET XYZ

The **SET XYZ** command in the **JOG** mode works the same as the **SET XYZ** command in the BASIC OPERATIONS mode. It prompts the user to reset any of the X, Y, or Z coordinates.

2 MOV INC

The **MOV INC** command in the **JOG** mode works the same as the **MOV INC** command in the BASIC OPERATIONS mode. It prompts the user to enter distances to move in each direction.

3 MOV ABS

The **MOV ABS** command in the **JOG** mode works the same as the **MOV ABS** command in the BASIC OPERATIONS mode. It prompts the user to enter a set of coordinates to which the tool is then moved.

. SAVE PT

The **SAVE PT** command in the **JOG** mode works the same as the **SAVE PT** command in the BASIC OPERATIONS mode. It allows the operator to store up to 100 points and replay these as positioning or milling events. For more information about the **TEACH** mode and the **SAVE PT** command, see Chapter 11 TEACH MODE in this manual.

*** JOG Y** or **JOG X**

The + key in the **JOG** mode is labeled as either JOG X or JOG Y. This key switches from the current JOG screen to the JOG screen for the other axis (whichever axis is not currently active).

+ and –

The + key and the – key in the **JOG** mode are used to change the feedrate override. The + key increases the feedrate override value, and the – key decreases the feedrate override value.

CHAPTER 6
DO EVENT OPERATION

The EZ-TRAK has a DO EVENT mode in which instructions can be programmed and executed one at a time. This means that operations such as drilling bolt circles, or milling rectangular pockets, can be executed with a single programmed canned cycle instead of being performed manually. All of the EZ-TRAK's canned cycles described in this chapter can be executed from the DO EVENT mode.

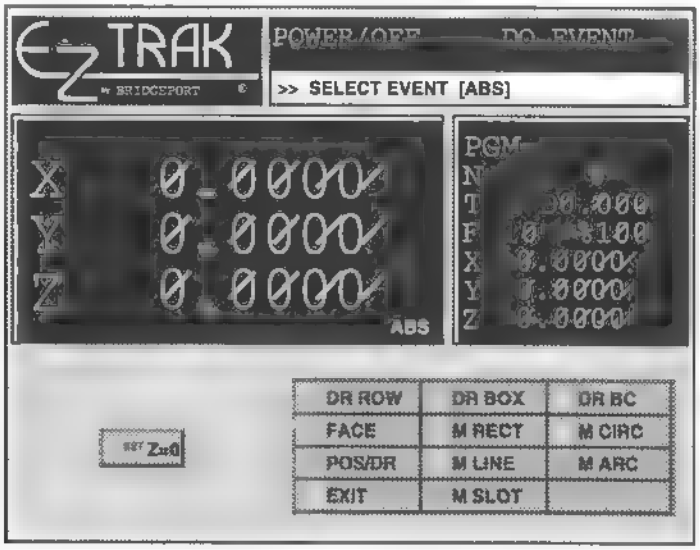


Figure 6-1

NOTE: DO EVENT operations are run directly from the DO EVENT screen and are not stored in system memory.

IMPORTANT: In the DO EVENT mode, the EZ-TRAK monitors the spindle. If the spindle is OFF when you press the + key to execute a programmed instruction, a message is displayed telling you that the instruction cannot occur unless the spindle is turned ON.

PART PROGRAM COORDINATE SYSTEM

When programming a part, the part program coordinate system must be established with reference to the machine coordinate system. During HOMING, the axes are moved to the HOME position. At the HOME position, the machine coordinates are set to the maximum travel values, X =30.0 Y =12.0. The HOME position for X and Y is mechanically set by the position of the X,Y axes HOME switches and a zero reference mark on the axis feedback encoders.

Use the **SET XYZ** command to orient the PART PROGRAM coordinate system with reference to the current position of the table.

ABSOLUTE AND INCREMENTAL PROGRAMMING

Coordinates in an operation can be input as either ABSOLUTE or INCREMENTAL data. Using INCREMENTAL input, a point is entered as the distance from the current tool location to the new location. Using ABSOLUTE input, the coordinates give the distance from the part program origin to the new tool location.

For example in Figure 6-2:

INCREMENTAL input: **X-5. Y4.**
ABSOLUTE input: **X4. Y7.**

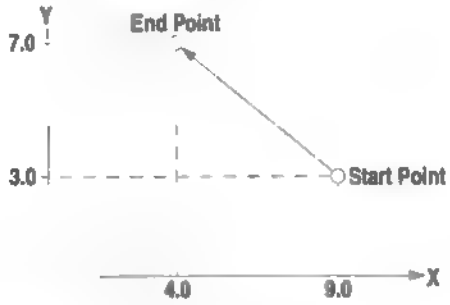


Figure 6-2

In addition, the center point of an arc can be programmed as either an INCREMENTAL or an ABSOLUTE dimension. In INCREMENTAL mode the center of the arc is given as the distance from the start point of the arc to the arc center. In ABSOLUTE mode the center of the arc is given by its coordinates from the part program origin.

For example in Figure 6-3:

INCREMENTAL input: **X0. Y-4. XC0. YC-2.**
ABSOLUTE input: **X-2. Y1. XC-2. YC3.**

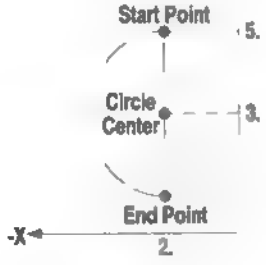


Figure 6-3

The **POS/DR**, **M LINE**, **M ARC**, and **DR ROW** commands can use the INCREMENTAL mode. To select the INCREMENTAL mode, select one of these commands, then press the + key. The data window is changed automatically to accept INCREMENTAL data.

USING THE DO EVENT COMMANDS

The DO EVENT commands require the operator to enter data from the keyboard in order to perform the selected functions. Each command in the DO EVENT mode displays a data window at the right hand side of the screen when selected. Each data window is different, and each command requires different data. This chapter describes each of the DO EVENT commands in detail and explains the data required for each command.

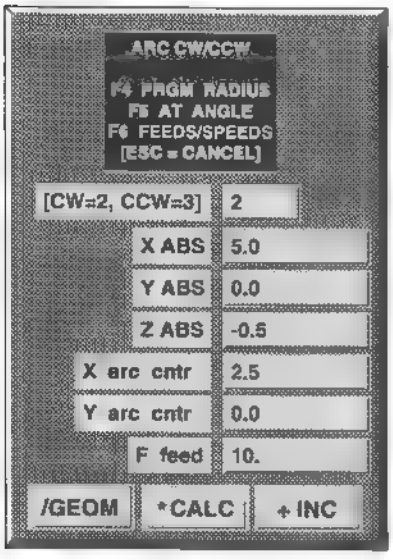


Figure 6-4

Figure 6-4 shows the data window from the **M ARC** command. The data required for this command includes the endpoint location for the tool, the center point of the arc, or its radius value and the milling feed rate. The direction (clockwise or counter-clockwise) is also required in this command.

At the bottom of the data window are three keys, labeled **/GEOM**, ***CALC**, and **+INC** (this key does not appear in all of the data windows, it appears as **ESC** in several commands). These keys are used to select the GEOMETRY HELP menu, the CALCULATOR functions, and to select the INCREMENTAL data entry mode if it is available. The **ESC** key can always be used to exit from the selected command. The GEOMETRY HELP and CALCULATOR modes are described briefly below. For more information on incremental programming, see Appendix A in this manual.

GEOMETRY HELP

The **/GEOM** key selects the GEOMETRY HELP menu. The functions in this menu are used to calculate point locations based on data which might be entered from a blueprint, or part drawing. The calculated point coordinates are entered automatically into the DO EVENT command when the calculation is finished. For a complete description of the GEOMETRY HELP functions, see Appendix E in this manual.

CALCULATOR

The ***CALC** key selects the CALCULATOR mode, which can be used to enter and solve a mathematical equation to find a coordinate, or other numeric value. For a complete description of the CALCULATOR mode, see Appendix B in this manual.

FEEDS / SPEEDS

In the milling commands in the DO EVENT and MDI modes, the **F6** key can be used to display a screen which will calculate an appropriate spindle speed and feedrate for the current command. Pertinent data such as work material, tool type and size and material, and type of cut are required to complete these calculations. See Appendix F in this manual for more information on the FEEDS & SPEEDS calculator.

0 EXIT

The **0 EXIT** key in the DO EVENT main screen exits the DO EVENT mode. The display is then returned to the BASIC OPERATIONS screen.

1 POS/DR

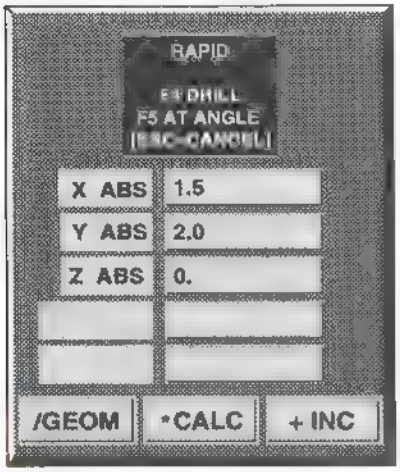


Figure 6-5

The **POS/DR** screen can be used to program two commands. By pressing the **F4** key, either **Position (Rapid)** or **Drill** can be programmed. Both of these commands move the tool from its current location to the programmed position. The **Drill** command prompts the operator to drill a hole to the programmed depth, once the tool has been moved to the new location.

For example, the programmed line:

```
0120 DR/PT ABS X2. Y1. Z-0.5
```

will instruct the EZ-TRAK to move from the current position to the location (2,1). The operator is then prompted to drill a hole at this location to the depth of **-0.5**.

The **Rapid** command moves the tool to the programmed position then waits for the next command.

Note: When using the **Rapid** positioning command, it is the operator's responsibility to move the Z axis to a height that clears the workpiece, before the move is executed.

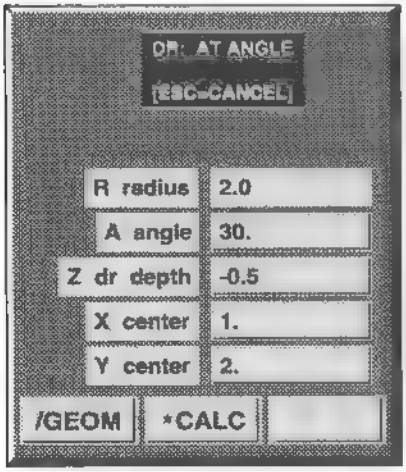


Figure 6-6

Both the **Rapid** and **Drill** commands can be programmed using **Polar Coordinates**. Pressing the **F5 AT ANGLE** key while the **POS/DR** instruction window is displayed changes the command to use **Polar Coordinates** to enter the new tool position.

For example, the programmed line:

```
0120 DR/ANGL ABS R2. A30 Z-0.5 XC1. YC2.
```

will instruct the EZ-TRAK to move the tool to the point shown in Figure 6-7. The operator is then prompted to drill a hole at this location to the depth of **-0.5**.

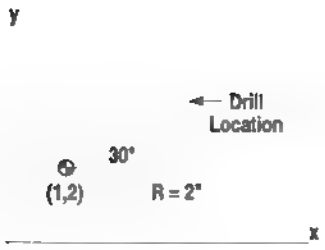


Figure 6-7

2 M LINE

The **M LINE** command causes the EZ-TRAK to move in a straight line at the **Feed** rate, to the location specified by the **X**, and **Y** coordinates.

When the **M LINE** command is selected from the DO EVENT screen, the screen displays the box shown in Figure 6-8. (If the EZ-TRAK has been set in **incremental** mode, the incremental distances for the line are required.)

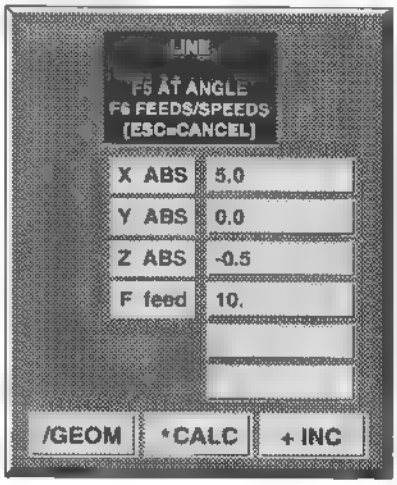


Figure 6-8

X ABS this is the X coordinate of the line endpoint
Y ABS this is the Y coordinate of the line endpoint
Z depth this is the coordinate showing the milling depth
F feed this is the feedrate for the milling operation

For example, the programmed line:

```
0130 LINE ABS X5. Y0. Z0. F10.
```

will instruct the EZ-TRAK to mill a straight line from the current position to the location (5,0).

If the tool was positioned at (0,5) when this line was executed, the tool movement would look like Figure 6-9 shown at the left.

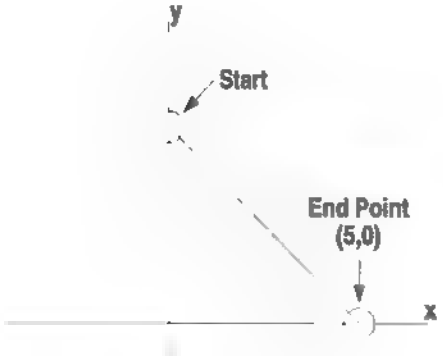


Figure 6-9

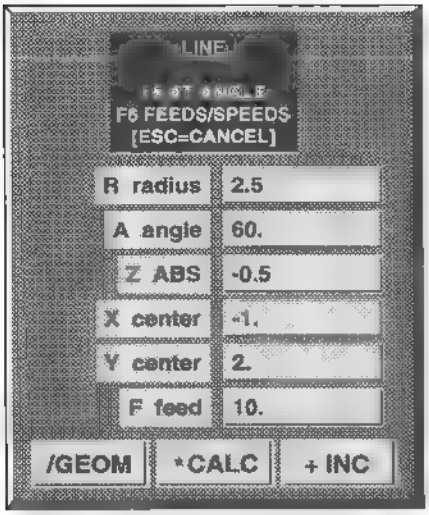


Figure 6-10

The **MLINE** command can be programmed using **Polar Coordinates**. Pressing the **F5 AT ANGLE** key while the **MLINE** instruction window is displayed changes the command to use **Polar Coordinates** to enter the new tool position.

For example, if the current tool location is (3,2), the programmed line:

```
0120 LINE/ANGL ABS R2.5 A60 Z-0.5 XC-1. YC2. F10.
```

will instruct the EZ-TRAK to move to the point shown in Figure 6-11. The movement of the tool in this command, is still a straight line from its previous position; however, the point is defined with radius and angle values.

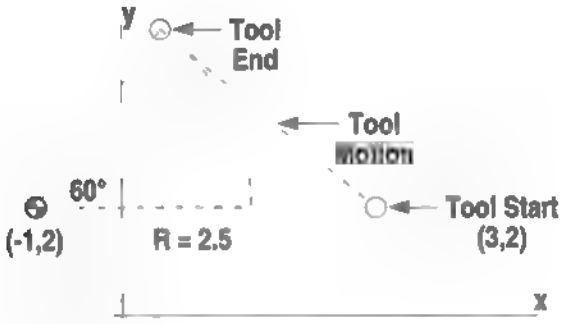


Figure 6-11

3 M ARC

The **M ARC** command is used to mill a path along an arc. The arc may be specified :

1. by its endpoint and the coordinates of the center of the arc.
2. if the arc is 180 degrees or less by its endpoint and the radius of the arc.

When the **M ARC** command is selected from the DO EVENT screen, the screen appears as in Figure 6-12.

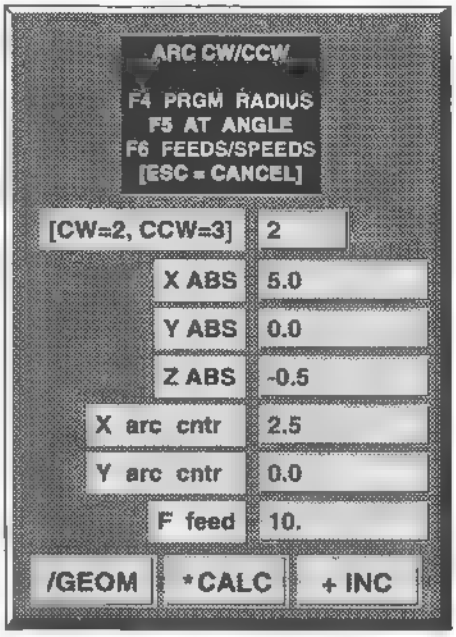


Figure 6-12

CW/CCW	this is the direction that the arc is to be milled (clockwise or counter-clockwise)
X ABS	this is the X coordinate of the endpoint of the arc
Y ABS	this is the Y coordinate of the endpoint of the arc
Z depth	this is the coordinate showing the milling depth
[X arc cntr	this is the X coordinate of the center point of the arc
Y arc cntr]	this is the Y coordinate of the center point of the arc
or [R radius]	this is the Radius of the arc (not necessary if **arc cntr** is used)
F feed	this is the feedrate in inches per minute of the milling move

For example, the instruction:

```
0150 ARC|CNTRPT ABS CW X5. Y0. Z0. XC2.5 YC0. F10.
```

will instruct the EZ-TRAK to mill an arc from the current position to the location (5,0). In this instruction, the arc is specified by its center point (2.5,0).

If the tool were at the location (0,0) when this instruction was executed, the tool movement would look like Figure 6-13.

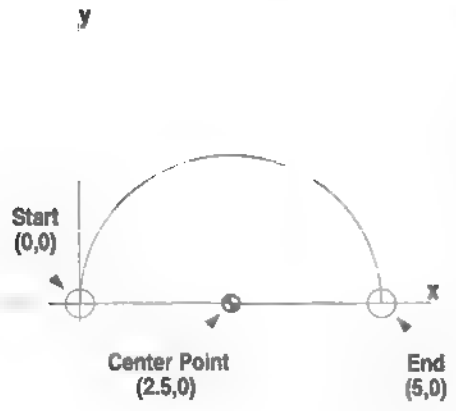


Figure 6-13

If this same arc were programmed by the radius of the arc, it would look like this:

```
0150 ARC|RADIUS ABS X5. Y0. Z-0.5 R2.5 F10.
```

This line produces the same motion shown in Figure 6-14 for the **ARC|CNTRPT** line.

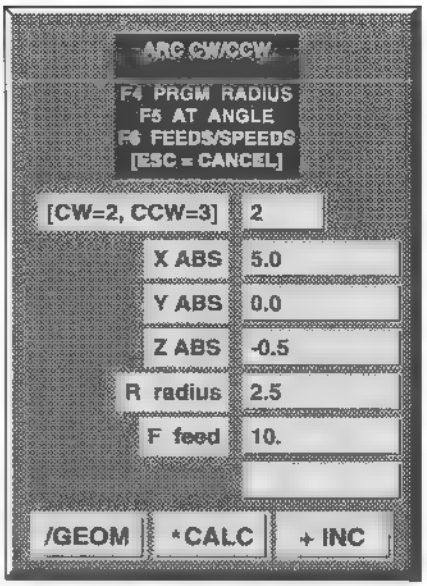


Figure 6-14

An arc can also be programmed by specifying the endpoint using **Polar Coordinates**. Pressing the **F5** key while the **M ARC** command window is displayed changes the command to accept the Radius and Angle parameters. These specify the endoint of the M ARC command.

For example:

The line programmed as shown in Figure 6-15:

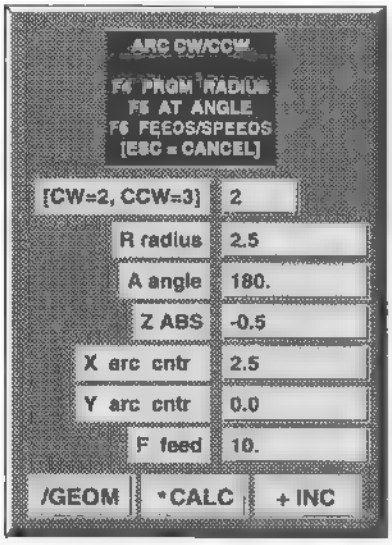


Figure 6-15

```
0020 ARC|ANGL ARC CW R2.5 A180. Z-0.5 XC2.5 YC0 F10.
```

will execute the same movement as shown in Figure 6-13.

NOTE: The **angle** must be input as an **absolute** value.

4 FACE

The **FACE** command face mills an area, designated by its length and width.

X_ is the incremental distance to be milled along the X axis.
Y_ is the incremental distance to be milled along the Y axis.
Y_ is the Y axis stepover.

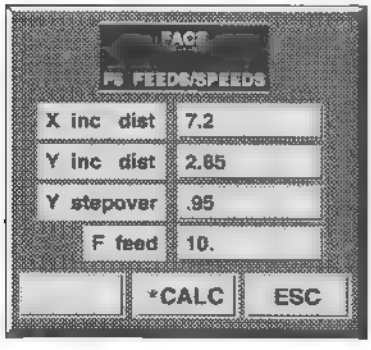


Figure 6-16

For example, the programmed instruction:

```
0160 FACE X7.2 Y2.85 Y.95 F10.
```

will face mill the 6.0 x 3.75 block shown in Figure 6-17.

The tool starts at the lower left corner of the face area when this operation is executed.

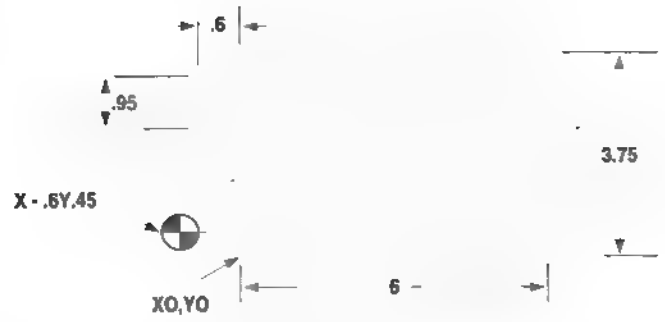


Figure 6-17

NOTE: It is possible to start at the top right hand corner of the face area, and proceed down and to the left. In this case, the X distance, and Y distance values are entered as negatives. The Y stepover value is always entered as an unsigned distance.

5 M RECT

The **M RECT** command is used to call three different milling routines. These routines each cut the rectangle in a different way. The routine called is determined by the value entered into the first field in the **M RECT** window. Enter a **0** to cut the outside border of the rectangle. Enter a **1** to cut the inside border of the rectangle. Or press the **F4** key to mill the interior of the rectangle as a pocket.

The system calculates the starting point for each cycle based on the approach value given. Each of these cycles performs both a roughing pass and a finishing pass. When the cycle is finished, the operator is prompted to raise the tool. The tool is then moved back to the center point of the rectangle.

NOTE: Pressing the **F5** key changes the **M RECT** command so that the rectangle is referenced by its left edge, and its bottom edge instead of the center coordinate.

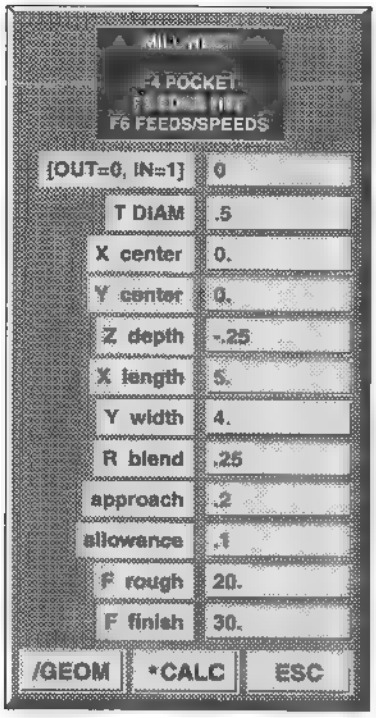


Figure 6-18

OUT/IN	determines what part of the rectangle is cut
T DIAM	is the diameter of the tool to be used
X_Y_	is the center point of the rectangle
Z_	is the depth
X_Y_	is the unsigned length and width
R_	is the fillet radius
approach_	is the initial entry clearance
allowance_	is the finish cut
F rough_	is the roughing feed rate
F finish_	in the finishing feed rate

OUTSIDE RECT MILL

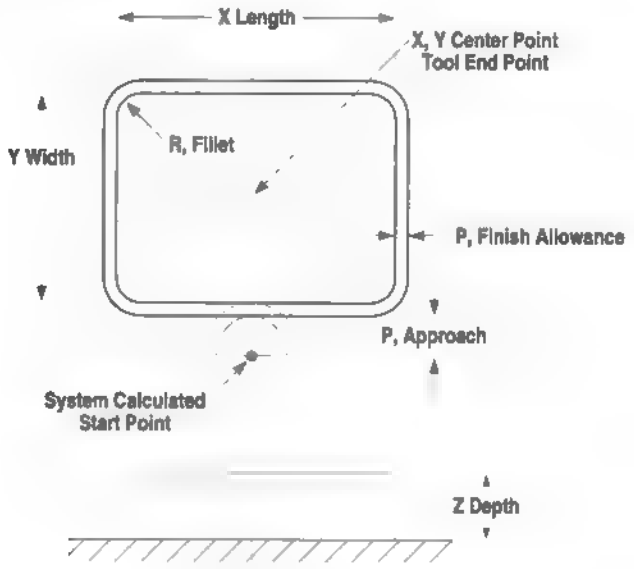


Figure 6-19

For example, this instruction:

```
RECT|CNTR OUT X0. Y0. Z-.25 X5. Y4. R.25 P.2 P.1 D.5 F20. F30.
```

Cuts the path shown in Figure 6-20.

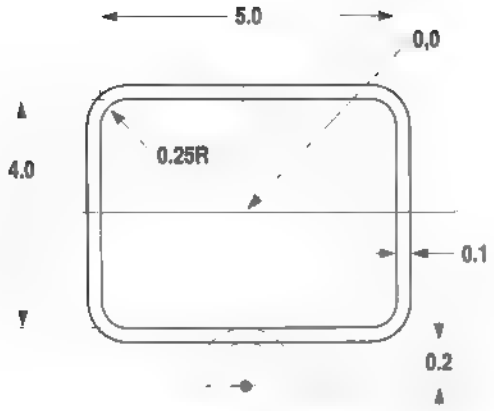


Figure 6-20.

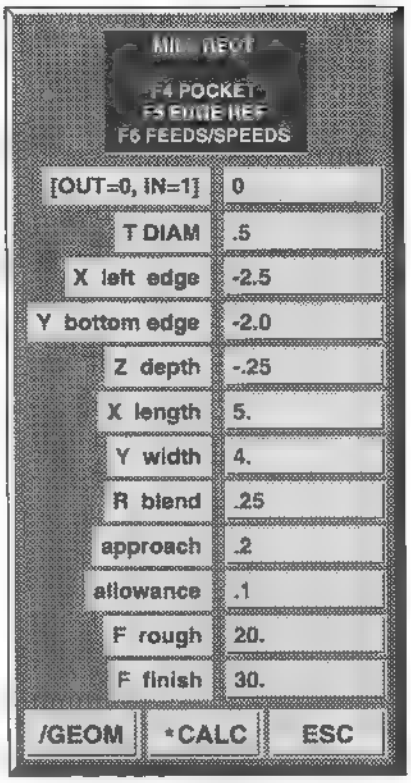


Figure 6-21

NOTE: In the **EDGE REFERENCE** mode the example in Figure 6-20 would be programmed as shown in Figure 6-21, creating the instruction:

```
RECT|EDGE OUT X-2.5 Y2. Z-.25 X5. Y4. R.25 P.2 P.1 D.5
F20. F30.
```

INSIDE RECT MILL

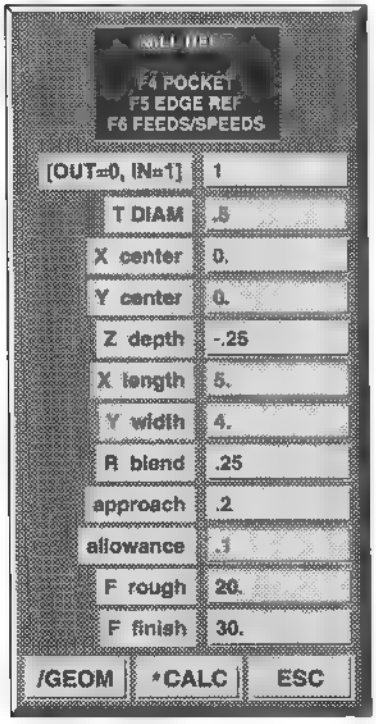


Figure 6-22

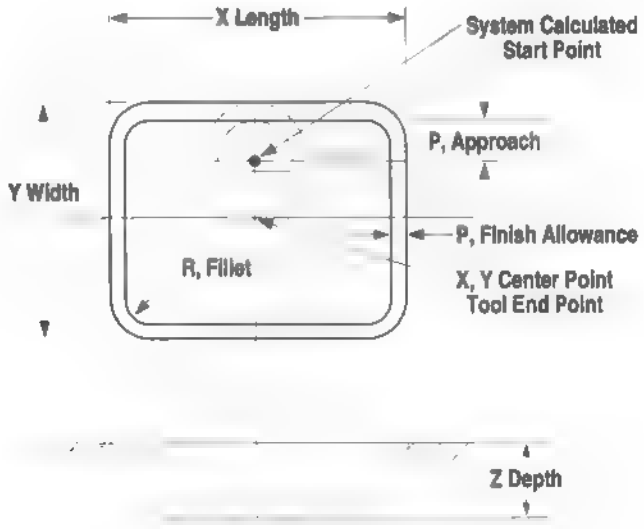


Figure 6-23

Figure 6-22 programs an inside rectangle. This data creates the instruction below:

```
RECT|CNTR IN X0. Y0. Z-.25 X5. Y4. R.25 P.2 P.1 D.5 F20. F30.
```

which cuts the path shown in Figure 6-24.

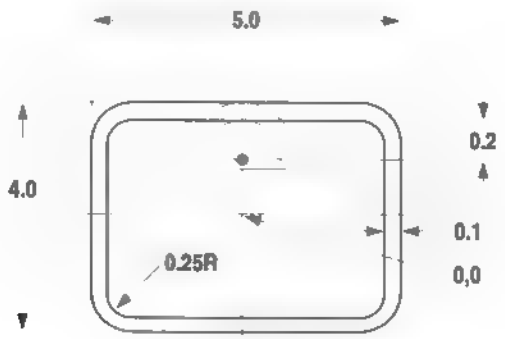


Figure 6-24

POCKET RECT MILL

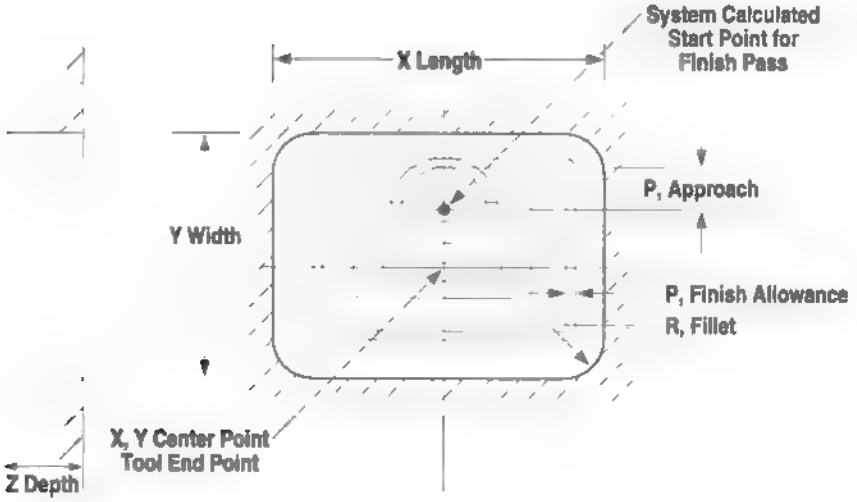


Figure 6-25

For example, this instruction:

```
RECT PKT|CNTR X0. Y0. Z-.25 X5. Y4. R.25 P.25 P.2 P.375 D.5 F20. F30.
```

Cuts the path shown in Figure 6-27.

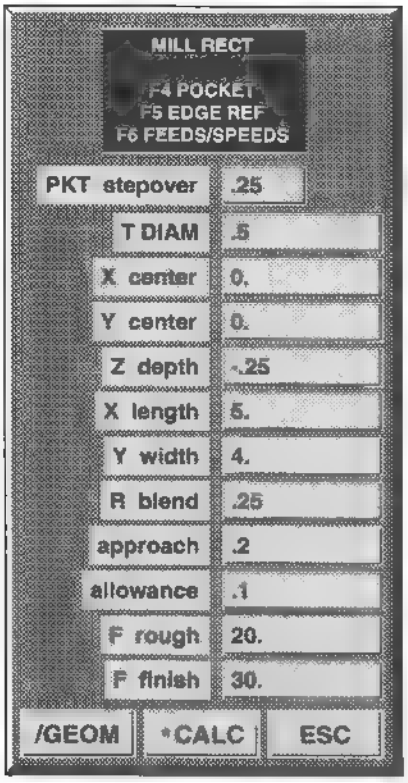


Figure 6-26

NOTE: PKT stepover_ is the tool stepover used in cutting the pocket

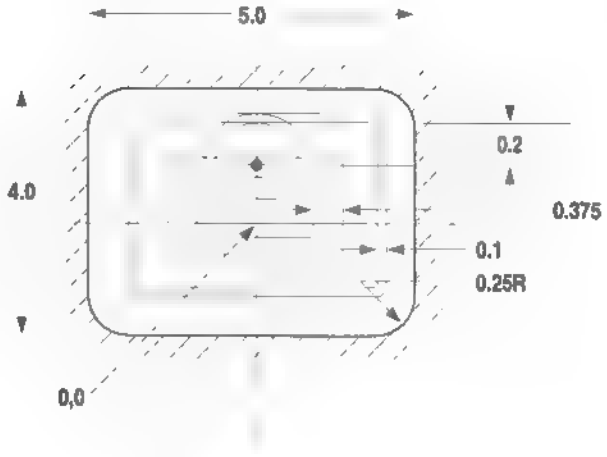


Figure 6-27

The rectangular pocket may also be referenced by its left edge and bottom edge, instead of the center coordinate. Press the **F5** key to use the **EDGE REFERENCE** mode.

6 M CIRC

The **M CIRC** command is used to call three different milling routines. These routines each cut a different circle. The routine called is determined by the value entered into the first field in the **M CIRC** window. Enter **0** to cut the outside border of a circle. Enter **1** to cut the inside border of a circle. Press the **F4** key to mill a circular pocket.

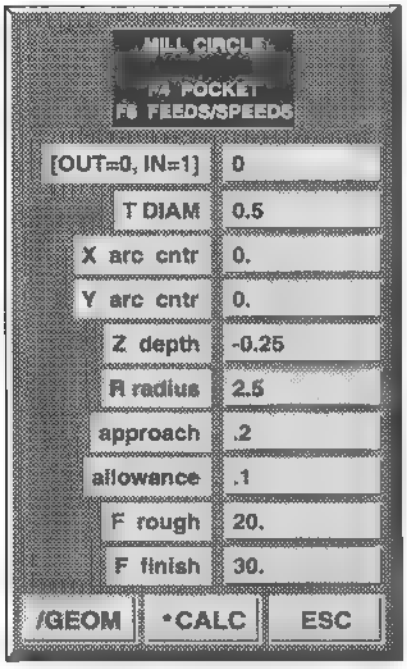


Figure 6-28

The system calculates the starting point for each cycle based on the approach value given. Each of these cycles performs both a roughing pass and a finishing pass. When the cycle is finished, the operator is prompted to raise the tool. The tool is then moved back to the center point of the circle.

IN/OUT	determines what will be cut
T DIAM	is the diameter of the tool to be used
X_Y_	is the center point of the circle
Z_	is the depth
R_	is the circle radius
approach_	is the initial entry clearance
allowance_	is the finish cut
PKT stepover_	is the stepover for clearing out the pocket
F_F_	is the rough and finish feeds

note: For pockets and inside circles, the tool radius, approach, allowance and stepover added together cannot exceed the radius of the pocket or circle.

OUTSIDE CIRCLE MILL

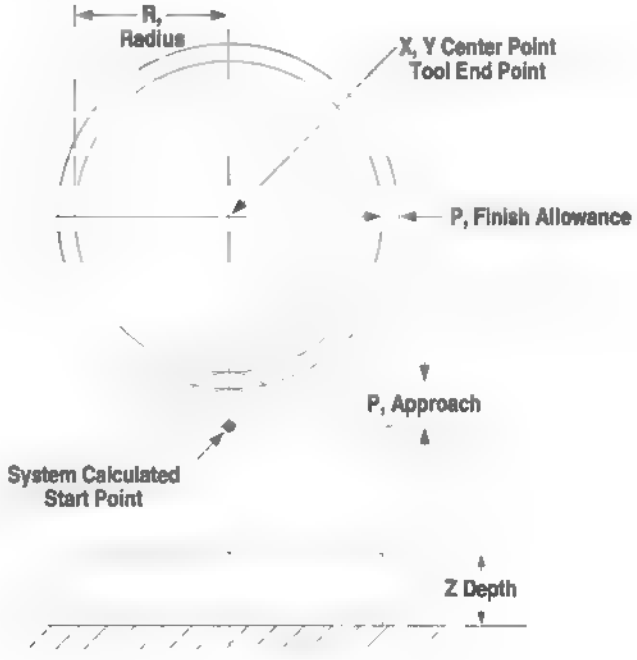


Figure 6-29

For example, this instruction:

```
CIRCLE OUT X0. Y0. Z-.25 R2.5 P.2 P.1 D.5 F20. F30.
```

Cuts the path shown in Figure 6-30.

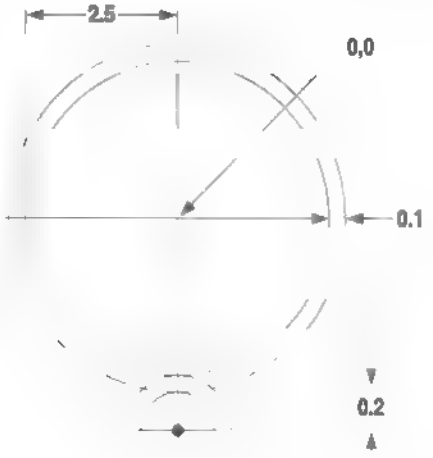


Figure 6-30

INSIDE CIRCLE MILL

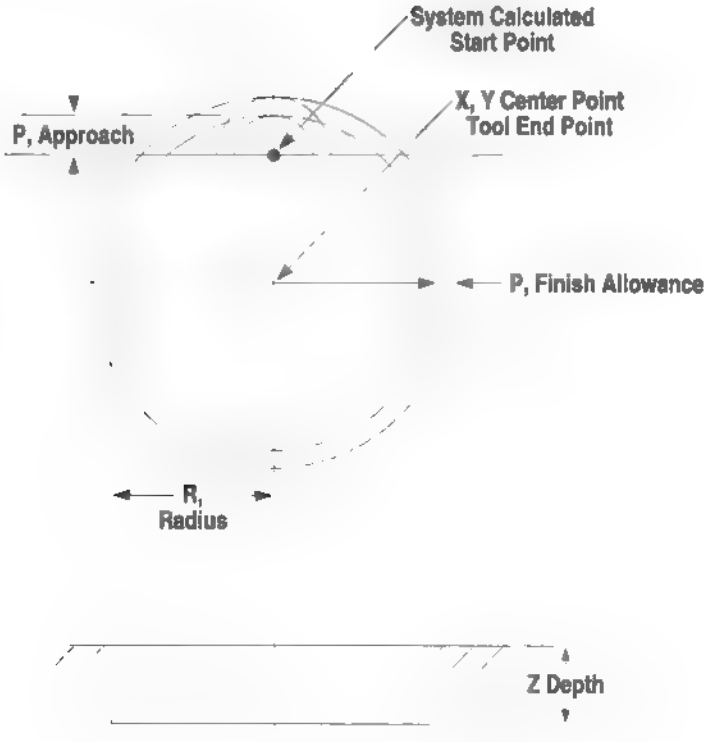


Figure 6-31

For example, this instruction:

```
CIRCLE IN X0. Y0. Z-.25 R2.5 P.2 P.1 D.5 F20. F30.
```

Cuts the path shown in Figure 6-32.

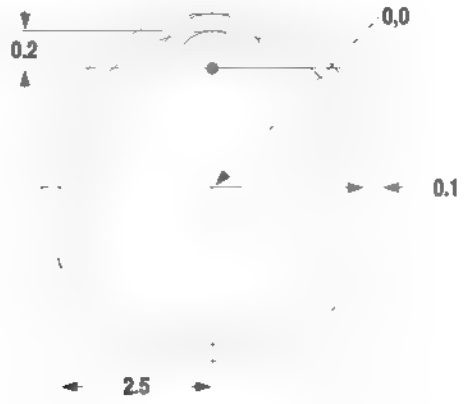


Figure 6-32

POCKET CIRCLE MILL

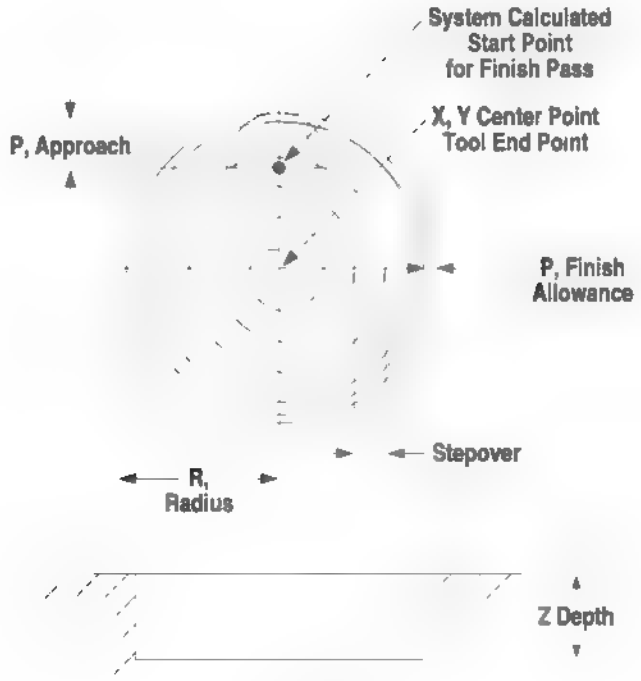


Figure 6-33

For example, this instruction:

```
CIRCLE PKT X0. Y0. Z-.25 R2.5 P.2 P.1 P.1875 D.5 F20. F30.
```

Cuts the path shown in Figure 6-34.

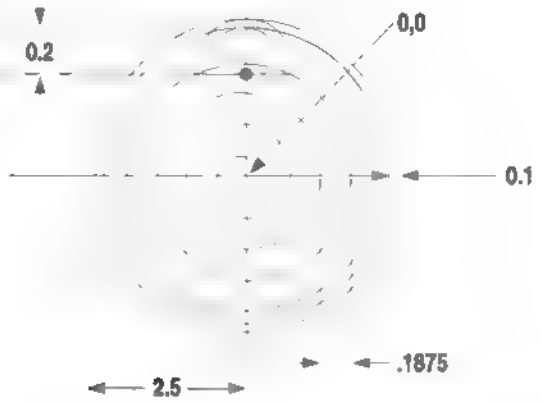


Figure 6-34

NOTE: The sum of the Stepover and Tool Radius cannot exceed the Pocket Radius.

7 DR ROW

The **DR ROW** command drills a row of holes beginning at a specified starting point. The holes in the row are evenly spaced from the set starting point over the row length given by the X and Y incremental distance values.

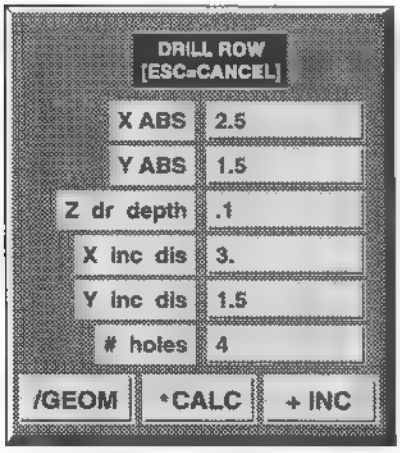
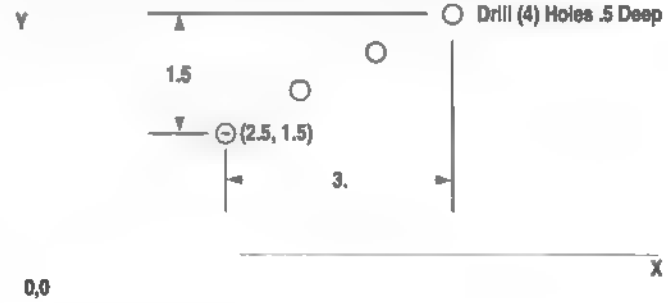


Figure 6-35

X_Y_ is the start point for the row
Z_ is the depth
X_Y_ is the incremental row distance
#_ is the number of holes




```
0010 DR/ROW ABS X2.5 Y1.5 Z.1 X3. Y1.5 P4
```

Figure 6-36

8 DR BOX

This command will drill holes along the perimeter of a rectangle.

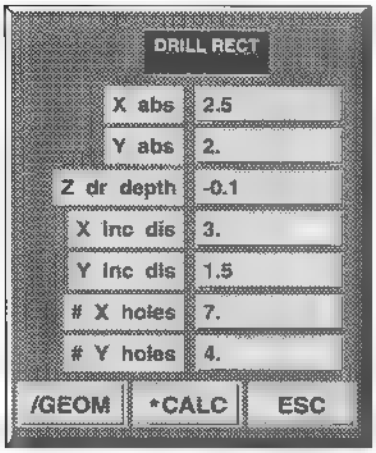


Figure 6-37

X_Y_ is the start point (bottom, left hole)
Z_ is the depth
X_Y_ is the incremental row distance
#_#_ is the number of holes in the X direction and the number of holes in the Y direction

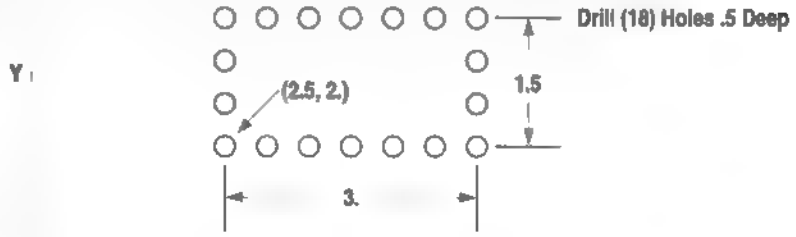


Figure 6-38

9 DR BC

This command will drill a series of holes along the perimeter of a bolt circle. The holes are spaced evenly from the start angle around the perimeter of the circle. Pressing the **F4** key changes this command to drill holes along an arc. Figure 6-42 shows an example of the arc command.

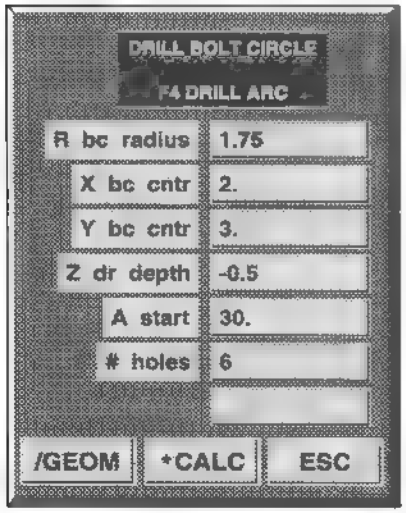


Figure 6-39

R_ is the bolt circle radius
XC_YC_ is the bolt circle center
Z_ is the depth
A_ is the start angle
#_ is the number of holes

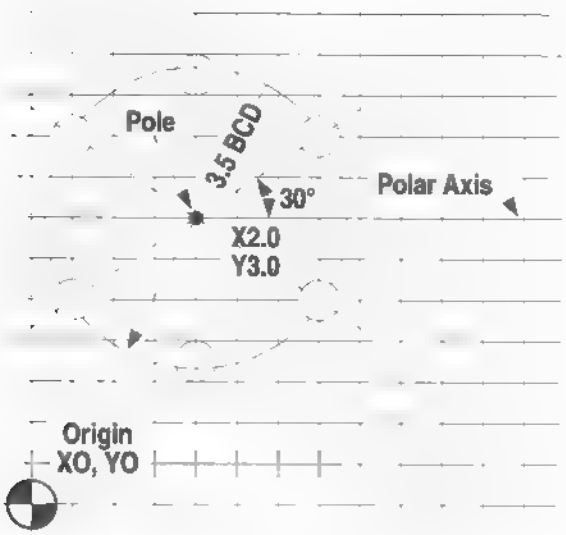


Figure 6-40

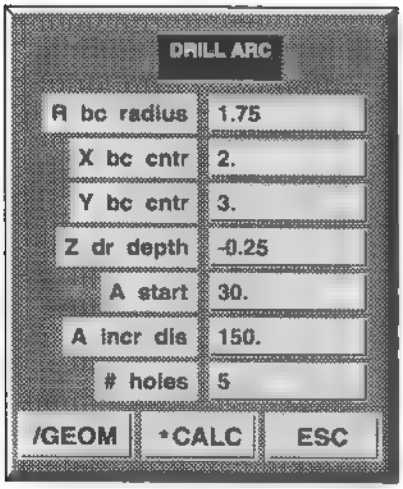


Figure 6-41

R_	is the bolt circle radius
XC_YC_	is the bolt circle center
Z_	is the depth
A_	is the start angle
A_	is the incremental angle from the first hole to the last hole
#_	is the number of holes

For example the programmed instruction:

```
DR|ARC R1.75 XC2.0 YC3.0 Z-0.25 A30 A150 P5
```

Drills a set of 5 holes as shown in Figure 6-42 below.

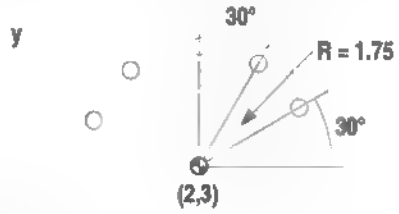


Figure 6-42

. M SLOT

Mills a slot at any angle to the X axis.

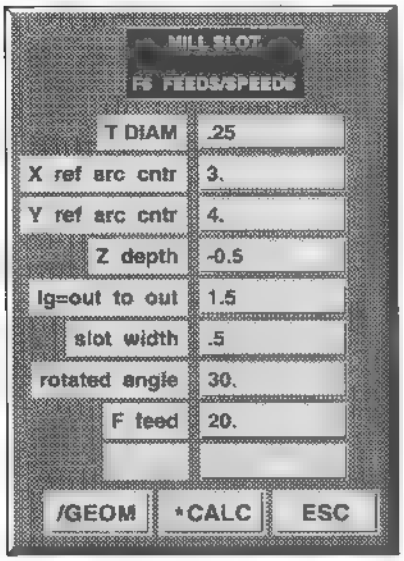


Figure 6-43

T_ is the tool diameter
X_Y_ is the center point of the left slot arc (see Fig. 6-44, below)
Z_ is the slot depth
out to out_ is the length of the slot end to end (the length must be a positive number)
width_ is the slot diameter.
rotation_ is the angular rotation from the X-axis

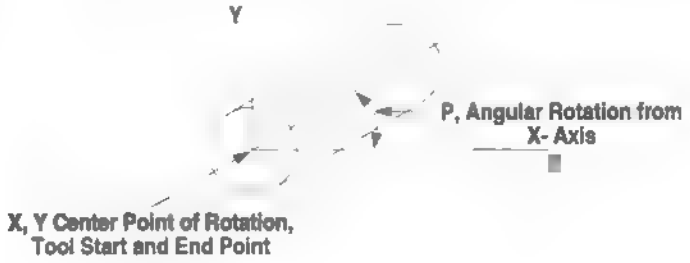


Figure 6-44

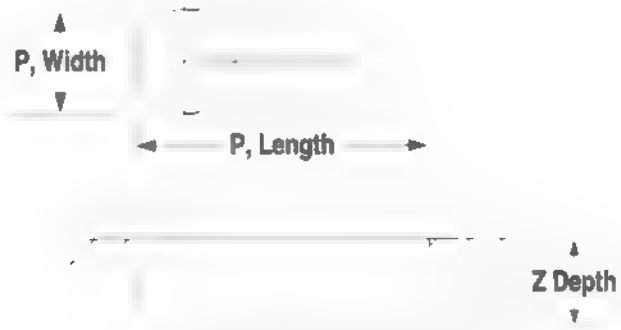


Figure 6-45

NOTE: The **SLOT** instruction temporarily executes a G92, (coordinate shift) causing the axes display to reset to zero before cutting the slot. The axes are reset to their previous values when the **SLOT** instruction is completed.

EXECUTING DO EVENT COMMANDS

After the DO EVENT data fields have been filled in the screen displays a **>>CHECK Z** message to the operator to make sure the tool quill is positioned properly. Below this message is the programmed instruction that is about to be executed. Be sure the spindle is turned on if a milling instruction has been programmed.

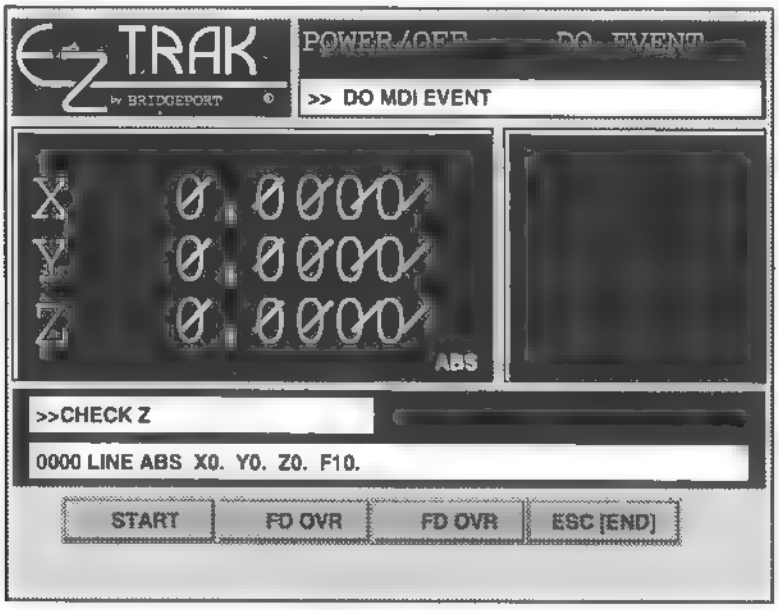


Figure 6-46

+ START will begin execution of the programmed operation

<cursor UP>
<cursor DOWN> FD OVR increases or decreases the feed override value.

ESC will abort the operation, and return to the DO EVENT screen.

This screen is displayed until the complete cycle is finished. The main DO EVENT screen is then displayed.

CHAPTER 7
MDI PROGRAMMING MODE

MDI PROGRAMMING

When the MDI mode is selected the screen displays:

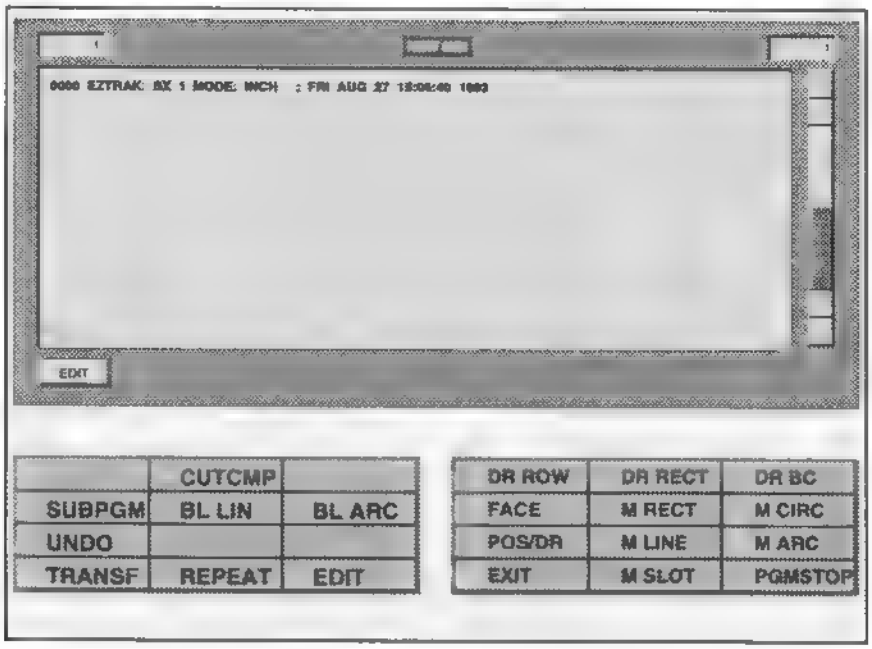


Figure 7-1

The MDI programming mode is used to program the EZ-TRAK to execute a series of machining operations. Each operation is programmed one at a time, by selecting the type of operation, then entering the data necessary to execute the command. An **UNDO** command is available in case a line is programmed incorrectly. All of the cycles which are available in the DO EVENT mode can be programmed as single instructions in the MDI programming mode. In addition, cutter compensation and tangent arcs (blends) can be used to simplify the cutter path programming.

After a part is programmed it can be saved to a 3.5" diskette, or hard drive on EZ-TRAK DX machines, for later re-use.

When the MDI mode is entered, the first line of the part program is written out automatically. This line reads:

```
0000 EZTRAK|SX 1 MODE|INCH  | MON AUG 30 14:21:00 1993
```

This determines that the program was written on the EZ-TRAK and also establishes the unit of measure for the part program, as well as the date and time it was written. The unit of measure is determined **before** the MDI mode is selected. To program in millimeters, change the EZ-TRAK's display before selecting the MDI mode.

NOTE: The first instruction in an EZ-TRAK program should be in absolute coordinates. The first instruction after a REPEAT command should also be programmed in absolute coordinates.

CONNECTIVE EVENTS

The EZ-TRAK constantly monitors the tool position. Each operation in a part program must give a target location, a position which the tool is moving to, and the type of movement, such as a clockwise arc move, a linear move etc.

To simplify programming, the EZ-TRAK always assumes that the tool is moving FROM its current position TO the target position, the location given in the programmed operation. It is important to be aware of the ending point in each of the canned cycles.

The operator is responsible for making Z AXIS moves. The EZ-TRAK checks for impending Z AXIS moves by looking at the programmed value of the Z move field.

NOTE: The EZ-TRAK does not check the ACTUAL value of where the Z-AXIS (the quill) is, only the PROGRAMMED value. It is up to the operator to properly position the Z AXIS.

When a Z AXIS move is programmed, the EZ-TRAK will stop the program, and prompt the operator to position the Z AXIS correctly, and then press the START button. When START is pressed, the program execution continues whether the Z AXIS has moved or not. In the case of a programmed +Z move (tool up) that is not made, the part may be accidentally machined off.

It is important to program the Z field when it is asked for in each operation so that the EZ-TRAK will properly prompt the operator to make Z AXIS moves. *The prompt display window is at the top right of the screen*.

NOTE: It is not necessary to program the actual Z dimensions required to machine the part, although it would be good practice to do so. In determining when OPERATOR INTERVENTION STOPS occur, the EZ-TRAK checks the next move to see if the Z AXIS position is the SAME value as the current programmed value (NO INTERVENTION), if the next move is above the current value (+Z , move the QUILL UP), or if the next move is below the current value (-Z, move the QUILL DOWN). If there is a change in the programmed Z value the EZ-TRAK prompts the operator to **CHECK Z**, or **SET Z** according to the programmed instruction.

By looking at the programmed Z axis position, and the type of programmed move, the EZ-TRAK determines whether OPERATOR INTERVENTION STOPs occur between moves, and whether it is necessary to prompt the operator to adjust the Z axis. The EZ-TRAK obeys the following set of rules when any programmed instruction is executed.

1. RAPID (positioning) moves:

If **not** DRILLING:

If the next Z move is **UP** (+Z), the system will STOP and the operator will be prompted to move the Z axis UP ***before*** making the XY move.

If the next Z move is **DOWN** (-Z), the system will STOP and the operator will be prompted to move the Z axis DOWN ***after*** the XY move.

If the next Z move is the **SAME** as the current programmed Z value, no operator message will be displayed and the move will occur.

If DRILLING:

Programmed Drill Cycles consist of a RAPID move to position the tool over the DRILL hole and then a FEED move down (done by the OPERATOR). For convenience the Z axis clearance height between holes has been pre-set to 0. It would be a good idea to program a TOOL CHANGE command prior to entering a DRILL CYCLE. The EZ-TRAK will make a RAPID move to DRILL position and then STOP and wait for the OPERATOR to DRILL the hole (see below).

2. If NOT RAPID (i.e. cutting)

if DRILLING (canned drilling cycles, such as bolt circle)

If the next Z move is DOWN, the system will STOP and the operator will be prompted to DRILL. The small system status readout will display the programmed Z DRILL depth.

if not DRILLING (feed moves, such as mill arc, or mill pocket)

If **any** Z move occurs (UP or DOWN) the system will STOP ***before*** the XY move is made and the operator will be prompted to MOVE Z.

3. CANNED CYCLES

The first move in a canned cycle is a RAPID move to the beginning of the cycle **at the clearance height**. The default clearance height for the EZ-TRAK is Z=0. The rules given above for Z Axis Operator Prompts for RAPID (positioning) moves apply. For example, in the following program:

```
0010 ||TOOLCHG T1
0020 RAPID ABS X0 Y0 Z0
0030 CIRCLE IN X2 Y2 Z-.5 R1. P.3 P.1 D.25 F40 F50
0040 CIRCLE PRT X1 Y1 Z-.375 R1 P.3 P.1 P.2 D.25 F40 F50
```

Assuming the tables initially are at X0 Y0 Z0, when the **START** key is pressed, the following operator message will be displayed.

CHANGE TO TOOL 1

After the **START** key is pressed the axes will move to the start point of the circle cycle (X=2., Y=2.5) and stop. The following message will be displayed.

POSITION Z AXIS
HIT [START] WHEN READY

The program status display will indicate the operator should make a Z move of **–.5** (as programmed in sequence 30).

After the **START** key is pressed, the axes will execute the INSIDE CIRCLE canned cycle.

At the end of the cycle, tool motion will stop, and the operator prompt message will display:

POSITION Z AXIS
HIT [START] WHEN READY

The program status display will indicate the operator should move the quill back to the Z clearance plane (Z=0). After the **START** key is hit, the program execution will continue.

If sequence 20 was programmed with a Z height of greater than the Z clearance for the canned cycle (default value of Z=0.)

```
0020 RAPID ABS X0 Y0 Z.1
```

when the **START** key is pressed after the CHANGE TO TOOL 1 message (and assuming the axes are at X=0, Y=0) the operator prompt message will display:

POSITION Z AXIS
HIT [START] WHEN READY

The operator will be prompted to make a Z move to Z=.1.

When the **START** key is hit, the axes will move to the beginning of the INSIDE CIRCLE (X2., Y=2.5). The following message will be displayed:

POSITION Z AXIS
HIT [START] WHEN READY

The operator will be prompted to move the quill to the Z axis clearance plane [Z=0]. When the **START** key is pressed, **no motion will occur**. The display will again read:

POSITION Z AXIS
HIT [START] WHEN READY

The operator will now be prompted to move the quill to the depth specified in the INSIDE CIRCLE cycle (Z=-.5). When the **START** key is pressed, the axes will execute the INSIDE CIRCLE cycle.

If sequence 20 was programmed with a Z height less than the Z clearance for the canned cycle:

```
0020 RAPID ABS X0 Y0 Z-.25
```

when the **START** key is hit after the CHANGE TO TOOL 1 message, (and assuming the axes are at X=0, Y=0), the operator prompt message will display:

POSITION Z AXIS
HIT [START] WHEN READY

The operator will be prompted to make a Z move to Z=-.1. When the **START** key is pressed, **no motion will occur**. The display will again read:

POSITION Z AXIS
HIT [START] WHEN READY

The operator is now prompted to move the quill to the Z axis clearance plane [Z=0.]. When the **START** key is pressed, the axes will move to the start point of the INSIDE CIRCLE canned cycle (X=2., Y=2.5). The operator prompt message will display:

POSITION Z AXIS
HIT [START] WHEN READY

The operator will be prompted to move the quill to the depth specified in the cycle (Z=-.5). When the **START** key is pressed, the axes will execute the INSIDE CIRCLE cycle.

4. **TOOL CHANGES.**

If the previously programmed Z axis depth is less than 0, the following operator message prompt will occur:

POSITION Z AXIS
HIT [START] WHEN READY

The operator is prompted to move the quill to Z=0. When the **START** key is hit, the tool change message will be displayed:

CHANGE TO TOOL [1].

To resume program execution, press the **START** key.

CUTTER COMPENSATION

In order to program the correct part shape, an allowance must be made for the cutter size. The tool path is offset by the cutter's radius so that the tool's cutting edge is placed on the programmed path. The calculations necessary for this allowance can be very difficult in some situations. The cutter compensation routines in the EZ-TRAK greatly simplify this process.

Cutter compensation can be used in the following ways:

1. In the EZ-TRAK the part shape can be programmed directly by the programmer. Using cutter comp the EZ-TRAK will automatically generate the tool path offsets.

2. If the tool wears or breaks and the same size tool is not available, cutter comp can be used to modify the program to allow for the changes in tool size.

3. Two or more different comp values can be used to create roughing, semi-finish and finish passes.

The tool placement and cutting direction must be specified when using cutter compensation. The tool is placed to one side of the programmed path (also the part's edge) to allow for the tool's size. This placement must be on the correct side (LEFT or RIGHT) for the direction of the tool's movement. These placements are specified with TOOL LEFT, or TOOL RIGHT.

To determine which placement (TOOL LEFT or TOOL RIGHT) is correct, imagine that you are standing on the programmed path behind the tool, and that you are looking at the tool as it moves away from you. If the tool is on your left, then the TOOL LEFT placement is correct. If the tool is on your right, then the TOOL RIGHT placement is correct.

REMEMBER:

Tool placement with respect to the part is always determined by looking from behind the tool in the direction of motion.

Figure 7-2

Figure 7-3

With standard right hand milling cutters:

TOOL LEFT = Climb Milling

TOOL RIGHT = Conventional Milling

RULES FOR USING CUTTER COMPENSATION

1. If the part program calls for cutting a concave or notch-like feature in the part, the cutter diameter must be no greater than the diameter or width of the feature to be cut. If the cutter diameter is larger than the width of the feature to be cut, gouging occurs, as in Figure 7-4, below.

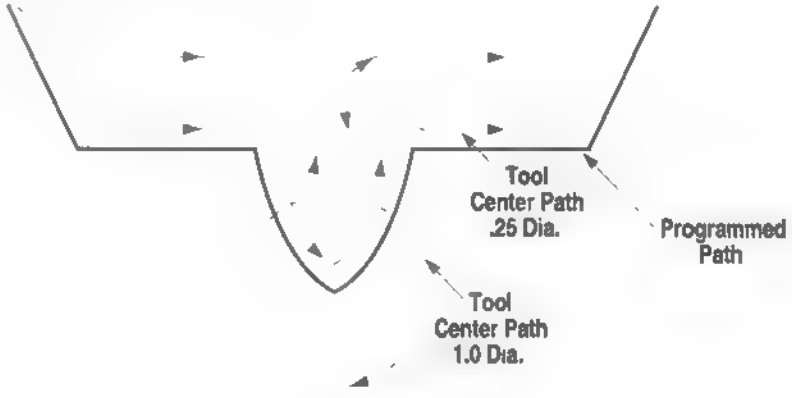


Figure 7-4

2. If the program calls for making a step less than the cutter radius, gouging occurs if corner rounding is turned on. Corner rounding may be turned off in the cutter compensation mode, to correct this problem. See Figure 7-5.

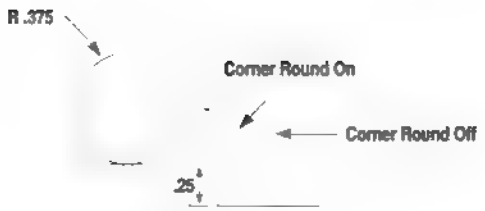


Figure 7-5

3. **Co-linear moves cannot be programmed**. Do not program two consecutive linear moves on the same line in cutter compensation.

4. **A Z move may be programmed in LINE or BL LIN only**. For example:

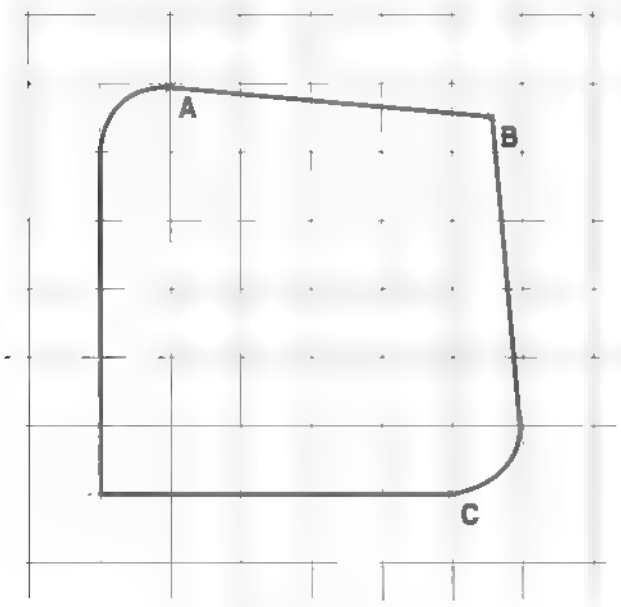


Figure 7-6

```
0010 COMP|ON LFT D.5 X0 Y0 Z.1 Z-.1
      P.5 F50
0020 BLEND|LN ABS X0 Y6 Z-.1 R1. CW
      F50
0030 LINE ABS X5.5 Y5.5 Z.1 F50
0040 BLEND|LN ABS X6. Y0 Z-.1 R1. CW
      F50
0050 LINE ABS X0 Y0 Z.1 F50
0060 COMP|OFF Z.5
```

Changes in Z depth are programmed in sequence numbers 30, 40 and 50. Operator prompt messages for Z moves will occur at positions A, B, and C in Figure 7-6.

NOTE: It is **not** valid to program a Z move in an **ARC** or **BLEND ARC** instruction.

5. **Only M LINE, M ARC, BL LIN, and BL ARC moves are allowed**. When cutter compensation is turned on the command keys are changed so that only the legal instructions for the cutter comp mode are displayed. **Do not add any other program lines between COMP ON and COMP OFF** To add illegal cutter comp lines later will cause errors in execution, and will halt the program prematurely.

STARTING UP CUTTER COMPENSATION

Starting the cutter compensation requires some special tool movements. These movements are calculated and created by the EZ-TRAK, however, it is important to understand how the moves are created so that the part can be designed and cut correctly.

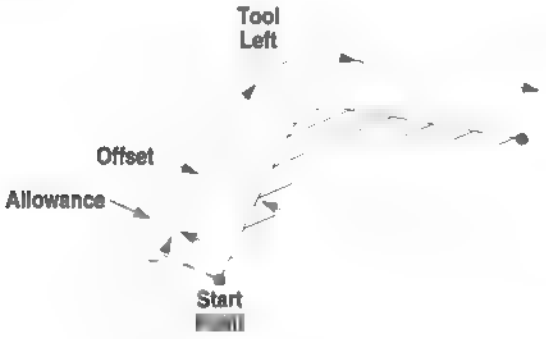


Figure 7-7

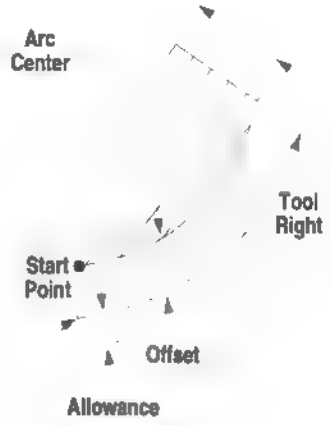


Figure 7-8

The tool moves to a point offset from the path by the tool radius plus the allowance. The tool approaches the path with an arc move that is tangent to the path at the start point. The radius of the arc is half of the allowance value. This is shown in Figure 7-7 and 7-8 above, for a linear move (M LINE, or BL LIN), and an arc move (M ARC or BL ARC).

F2 COMPON

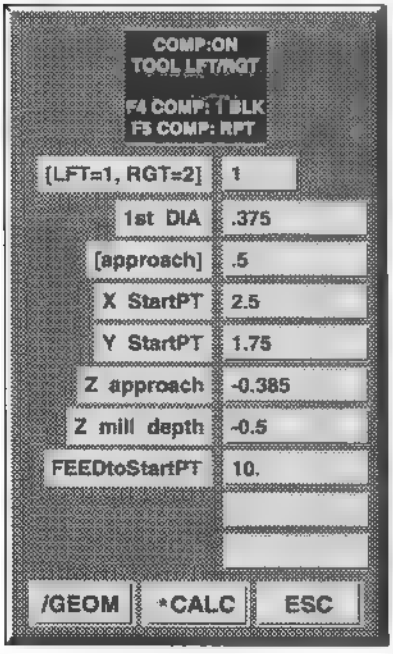


Figure 7-9

This instruction turns on the cutter compensation feature creating tool movements as described above.

LFT/RGT	is the direction of cutter offset
1st DIA.	is the tool diameter for the first cut
approach	is the approach distance
X_Y_	is the start point of the first line or arc to be compensated
Z approach	is the approach depth
Z mill depth	is the milling depth.
FEED to Start PT	is the feed rate to the start point.

This command has two optional modes, which are selected by pressing the **F4 COMP: 1 BLK** and **F5 COMP:RPT** keys.

The **F4** key selects the **COMP 1BLK** command which turns on the cutter compensation feature for only one programmed instruction. The ramp on and ramp off movements are created the same as the usual COMP ON command. Do **not** put a **COMP OFF** line after COMP 1BLK. The program for Figure 7-10 would look like this:

```
0010 COMP|1BLK LFT D.5 X0 Y0 Z-.1 Z-.25 P.375 F10.
0020 LINE ABS X2.0 Y2.0 Z-.25 F10.
```

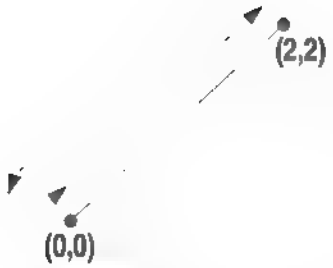


Figure 7-10

The **F5 COMP:RPT** mode can create both roughing and finishing passes with two different compensated diameters and feedrates. The instructions between **COMP ON** and **COMP OFF** are executed once, then the tool rapids back to the start point before the finish pass, using the second diameter and feedrate.

2nd DIA is the comp diameter of the second cut
2nd FEED is the feedrate of the second cut

CORNER ROUNDING IN CUTTER COMPENSATION

The angle of intersection created by two blocks of motion commands as measured on the workpiece side create an "inside" or "outside" corner. An inside-corner occurs when the angle is over 180 degrees, an outside-corner occurs when the angle is less than 180 degrees. (The two moves may also be tangent at the point of intersection).

If an outside corner occurs, a rounding arc is automatically blended through the point of intersection tangent to the two programmed paths. Figures 7-11 and 7-12 show inside corners which have an intersection angle greater than 180°. Figures 7-13 and 7-14 show outside corners which have an intersection angle less than 180°.

Figure 7-11

Figure 7-12

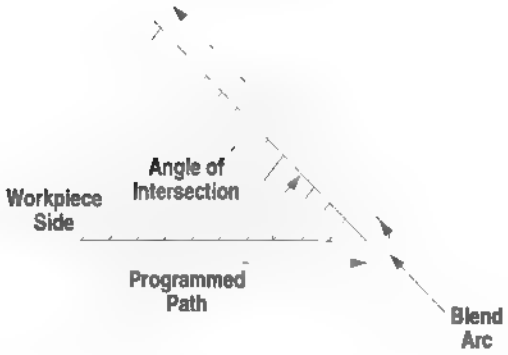


Figure 7-13

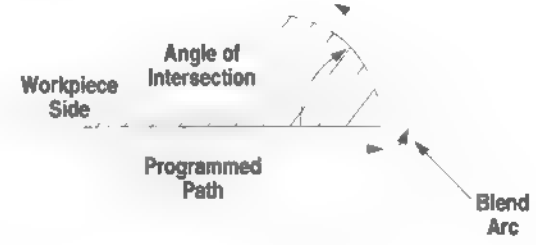


Figure 7-14

TURNING CORNER ROUNDING ON/OFF

Figure 7-15

When programming in the Cutter Comp mode, the corner rounding feature can cause gouging problems, especially when cutting small steps or notches. To avoid gouging, the corner rounding feature can be turned off while cutter comp is on.

To turn corner rounding off, select the right arrow key **C RND** after COMP ON has been programmed.

EXITING CUTTER COMPENSATION

Figure 7-16

The EZ-TRAK also uses a ramp off move to exit from the cutter compensation mode. The following shows examples of the cutter compensation exit moves.

If the last compensated move is a line, the compensation exit moves appear similar to Figure 7-16.

The tool moves to the end point of the programmed path, and then exits by making an arc move away from the path. The arc move has a radius value equal to half the allowance value.

If the last compensated move is an arc, the cutter comp exit moves appear similar to Figure 7-17.

The tool moves to the end point of the programmed path, and then exits by making an arc move away from the path. The arc move has a radius value equal to half the allowance value.

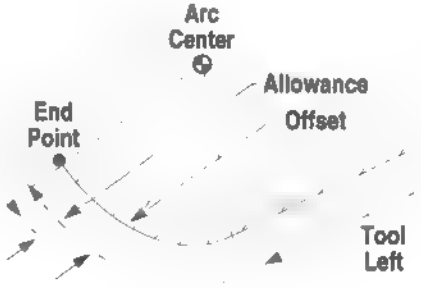


Figure 7-17

F2 CMPOFF

Figure 7-18

The **CMPOFF** command turns cutter compensation off. This move allows the user to enter a Z value so that the tool can be withdrawn from the part at the end of the cutter compensation.

Note: Do **not** use COMP OFF after a COMP 1 BLOCK command.

F4 SUBPGM

The **SUBPGM** command allows one program to call and execute another program as long as both are accessible in memory. There are no limits to the number of programs that can call each other. The **SUBPGM** command may be used with the **TRANSF** (**ROTATE**, **OFFSET**, or **MIRROR**) commands. An example of this is given in the section which describes the **TRANSF** command.

Figure 7-19

The **SUBPGM** command requires only the name of the program that is being called. Either a **.PGM** or a **.TXT** file may be used as a sub-program. Press the **F4** key to enter the name of **.TXT** file.

BLENDS

The EZ-TRAK provides commands in the MDI programming mode for placing tangent arc moves between lines and arcs (or any combination of lines and arcs). These moves are called **BLENDS** and are only available in the MDI programming mode. The two commands which program a blend are **BL LIN** and **BL ARC**.

To program a blend, the intersection of the two connecting entities must be given in the **X_Y_** fields. This point can be calculated using the *** CALC** or the **/GEO** utilities.

NOTE: The **BL LIN** and **BL ARC** commands cannot be programmed after a **COMP1 BLK** command, because these commands require two instructions to complete.

F5 BL LIN

This command places a blend arc after the programmed line. The **BL LIN** command requires the following parameters.

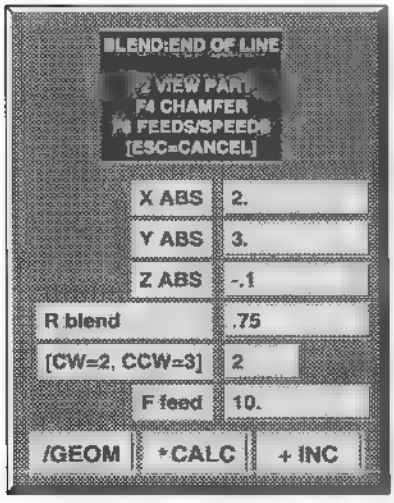


Figure 7-20

X_Y_ is the intersection of the LINE and the next LINE or ARC in the tool path (see Figure 7-21)

R_ is the blend radius

CW/CCW_ is the direction of the blend arc

F_ is the feedrate

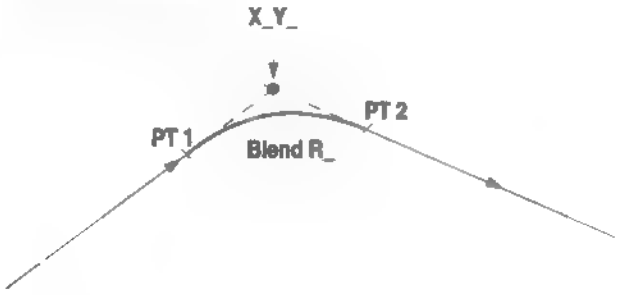


Figure 7-21

For example, this instruction:

```
0020 BLEND|LN ABS X2. Y3. R.75 CW F10.
```

cuts the path shown in Figure 7-22.

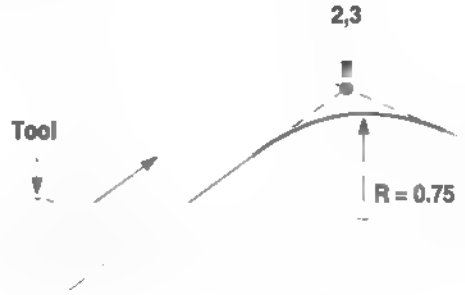


Figure 7-22

CHAMFER

The **BL LIN** command can also program a **CHAMFER**, a straight line that connects two linear moves. The **CHAMFER** is programmed by selecting the **BL LIN** command, then pressing the **F4** key. The **CHAMFER** command requires the following parameters.

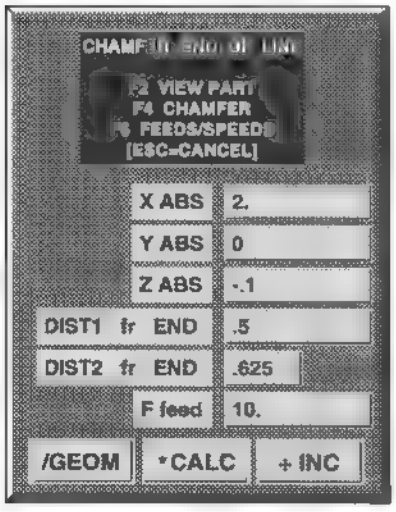


Figure 7-23

X_Y_	is the **ENDPT** of the LINE and the next move in the tool path (see Figure 7-24)
Z_	is the depth of the cut
DIST1 fr END	is the distance from PT1 to the ENDPT as shown in Figure 7-24, below
DIST2 fr END	is the distance from the ENDPT to PT2 as shown in Figure 7-24, below
F_	is the feedrate

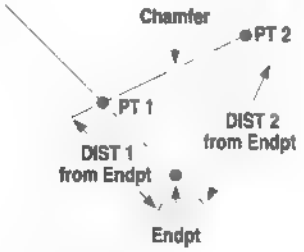


Figure 7-24

The instructions to program the example shown in Figure 7-25, would be:

```
10 CHAMFER ABS X2. Y0. Z-.1 P.5 P.625 F10.
20 LINE ABS X3 Y2 Z-.1 F10.
```

The first line programs the endpoint, where the two lines would intersect. It also sets the distances from this point, where the chamfer connects the two lines. The second line programs the linear move to the point (3,2).

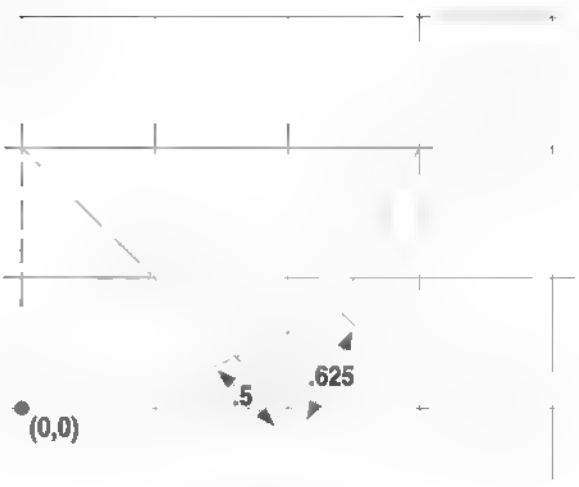


Figure 7-25

F6 BL ARC

This command places a blend arc at the end of the programmed arc. The **BL ARC** command requires the following parameters.

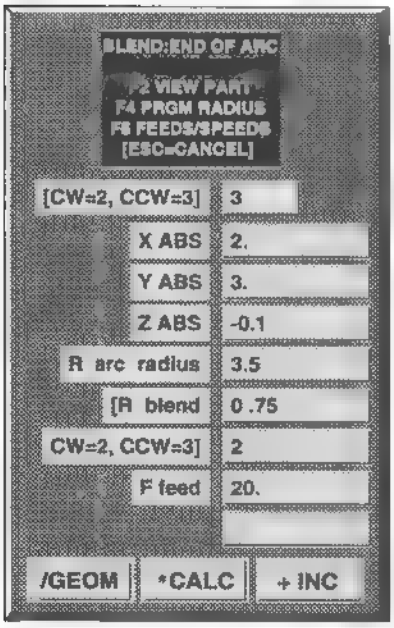


Figure 7-26

CW/CCW_	is the direction of the programmed ARC
X_Y_	is the intersection point of the ARC and the next LINE or ARC in the path (see Fig 7-27.)
XC_YC_	is the ARC center point
or **R_**	is the ARC radius
R blend	is the blend radius
CW/CCW_	is the direction of the blend arc
F_	is the feedrate

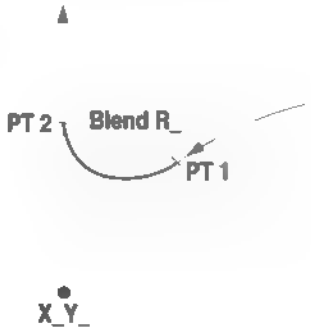


Figure 7-27

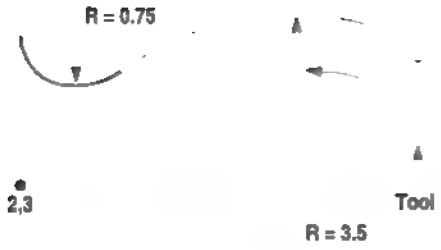


Figure 7-28

In this example, the tool cuts the arc to **PT1**, then cuts the blend arc, and ends at **PT2**.

The instruction to cut the path in Figure 7-28 would be:

```
0040 BLEND|ARC|RADIUS ABS CCW X2. Y3. R3.5
                R.75 CW F20
```

<down arrow> REPEAT The **REPEAT** command is used to create a loop in a part program that will cause one or more instructions to be repeated a specified number of times. A shift can also be entered, so that the instructions are repeated at another location on the part. The **REPEAT** command is placed at the beginning of the set of instructions to be repeated (enter the number of times the loop is repeated) and after the last instruction to be repeated (enter zero for the number of repeats).

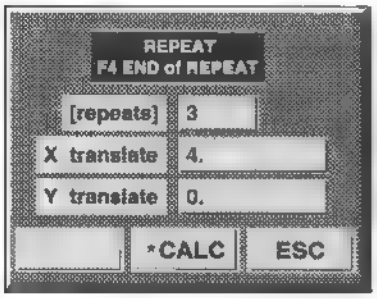


Figure 7-29

repeats This parameter sets the number of times the loop is executed.

X translate This parameter sets the shift in the X axis, between each execution of the loop.

Y translate This parameter sets the shift in the Y axis between each execution of the loop.

An example of the **REPEAT** command is given below.

```
0000 EZTRAK|SX 1 MODE:INCH
0010 REPEAT 3 X4. Y0.
0020 BOX PKT X0.00 Y0.00 Z-.5 X2. Y3. R.375 P.375 P0.5 P.125 D.25 F10. F15.
0030 END|REPEAT 0 X0. Y0.
0040 AUXFUN T2 M2
```

This program contains a loop that has one instruction, to cut a box pocket shape (line 0020). The first instruction (line 0010) establishes a loop that will be executed four times, with a shift of 4 inches in the X direction, and zero inches in the Y direction between each execution of the loop. Since the loop is executed four times, this program cuts four box pockets, and looks like Figure 7-30.

NOTE: The instruction is executed once, then repeated three times, resulting in four executions. The number of repeats should be the total number of executions minus one.

Figure 7-30

<right arrow> TRANSF This command can be used in three different ways.

1) It is used to offset the work coordinate system (see **OFFSET** below).

2) It is used to create a mirrored image of the part (see **MIRROR** below).

3) It is used to rotate the coordinate system (see **ROTATE** below).

OFFSET To use the **TRANSF** command to move the work coordinate system to another location (**OFFSET**), enter the offset values for both the X and Y directions.

Figure 7-31

X Offset This is the distance to be offset in the **X** axis

Y Offset This is the distance to be offset in the **Y** axis

NOTE: Once a translation (**OFFSET**) has been commanded, it remains in effect until it is reset. To reset the translation, use the **TRANSF** (**OFFSET**) command again, and enter **0** for both the **X** and **Y** offsets. This must be done before the end of the program.

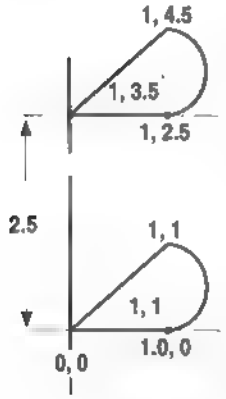


Figure 7-32

```
0000 EZTRAK|SX 1 MODE:INCH
0010 RAPID ABS X0.00 Y0.00 Z0.00
0020 LINE ABS X1. Y0.00 Z0.00 F30.
0030 ARC|CNTRPT ABS CCW X1. Y2. Z0. XC1. YC1.0 F30.
0040 LINE ABS X0. Y0. Z0. F30.
0050 TRANSLATE OFFSET X0 Y2.5
0060 RAPID ABS X0.00 Y0.00 Z0.00
0070 LINE ABS X1. Y0.00 Z0.00 F30.
0080 ARC|CNTRPT ABS CCW X1. Y2. Z0. XC1. YC1.0 F30.
0090 LINE ABS X0. Y0. Z0. F30.
0100 TRANSLATE OFFSET X0 Y0
```

Lines 10-40 cut the part in the base coordinate system. Line 50 offsets the coordinate system 2.5 inches in the Y direction. Lines 70-90 cut the part again. Line 100 resets the work coordinate system back to the original location. If another part were to be cut at the location **7.0,-3.0** the **TRANSF** command would be used again with the offsets **7.0** and **-3.0**.

When the **F4** key is pressed in the **TRANSF** command, a mirror image of the part can be created. The axis of reflection is the current tool location when the **MIRROR** command is executed. (Note in the example, that the tool is positioned back to **2.0,1.0** at the end of program 1, before each **MIRROR** command.)

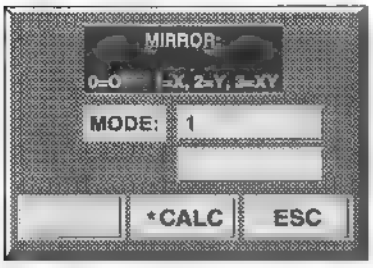


Figure 7-33

MIRROR MODE Enter the desired reflection number.
1 reflects across the X axis,
2 reflects across the Y axis,
3 reflects across both axes.

NOTE: Once a translation has been commanded, it remains in effect until it is reset. To reset the translation, use the **TRANSF** command again, and enter **0** for the **MIRROR MODE**. This must be done before the end of the program.

EXAMPLE OF MIRROR IMAGE (WITH SUBPROGRAM)

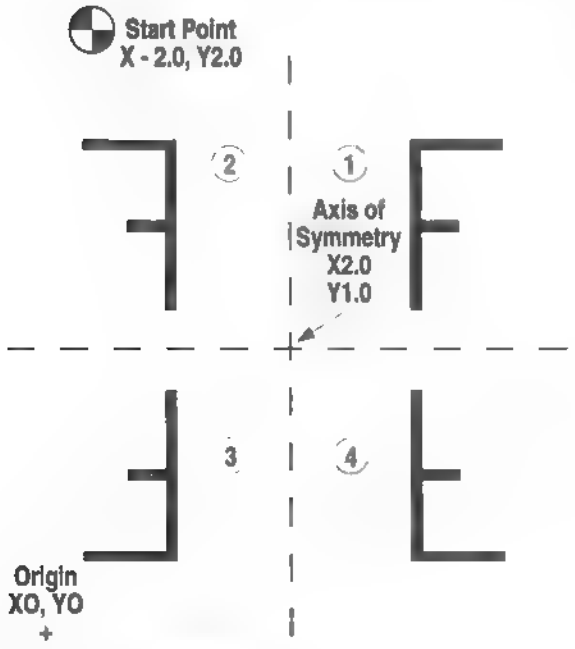


Figure 7-34

note: Program 2 must be the active program in order to run the subprogram. If a change is made to Program 1, Program 2 must be reloaded into the editor and saved in order to update changes made to Program 1.

Program 1 defines the shape

```
0000 EZTRAK 1 MODE:INCH
0010 RAPID ABS X2. Y1. Z.1
0020 RAPID ABS X3. Y1.25 Z.1
0030 LINE INC X0. Y.25 Z-.1 F10.
0040 LINE INC X.25 Y0. Z-.1 F10.
0050 LINE INC X-.25 Y0. Z-.1 F10.
0060 LINE INC X0. Y.25 Z-.1 F10.
0070 LINE INC X.3 Y0. Z-.1 F10.
0080 RAPID ABS X2. Y1. Z.1
```

Program 2 machines the various images

```
0000 EZTRAK 1 MODE:INCH
0010 RAPID ABS X-2. Y2. Z.1
0020 DO|SUBPRGM [PGM] 1
0030 TRANSLATE MIRROR X
0040 DO|SUBPRGM [PGM] 1
0050 TRANSLATE MIRROR XY
0060 DO|SUBPRGM [PGM] 1
0070 TRANSLATE MIRROR Y
0080 DO|SUBPRGM [PGM] 1
0090 TRANSLATE MIRROR OFF
0100 RAPID ABS X-2. Y2. Z.1
```

ROTATE

The **ROTATE** command is used to rotate the orientation of the part program through a specified angle. The center of the rotation is the part program origin (X=0, Y=0). After using the **ROTATE** command, the orientation of the part must be reset to its original position. This is done by calling the **ROTATE** command again, in the **absolute** mode, with an angle of zero. **ROTATE** is most often used with **REPEAT**.

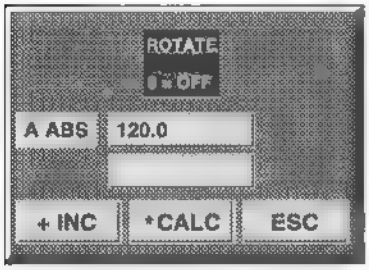


Figure 7-35

A_ This parameter gives the angle that determines how far the part orientation is rotated.

INC / ABS This changes the mode of measurement of the angle of rotation.

NOTE: When the **Rotate** command is used in the absolute mode, the angle is measured from the positive X axis as shown in Figure 7-36.

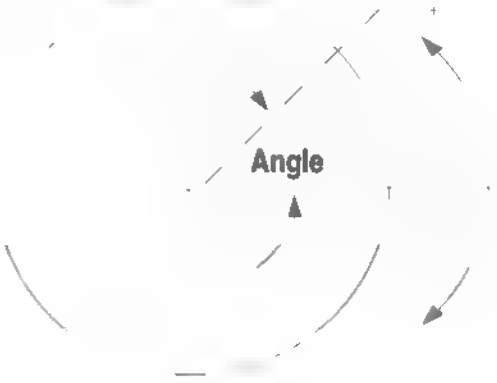


Figure 7-36

A simple example of using the **ROTATE** command is given below.

```
0000 EZTRAK|SX 1 MODE:INCH
0010 BOX PKT X0.00 Y3.00 Z-.5 X3. Y2. R.375
   P.375 P0.5 P.125 D.25 F10. F15.
0020 ROTATE|INC A120.0
0030 BOX PKT X0.00 Y3.00 Z-.5 X3. Y2. R.375 P.375 P0.5 P.125 D.25 F10. F15.
0040 ROTATE|INC A120.0
0050 BOX PKT X0.00 Y3.00 Z-.5 X3. Y2. R.375 P.375 P0.5 P.125 D.25 F10. F15.
0060 ROTATE|ABS A0.
0070 AUXFUN T2 M2
```

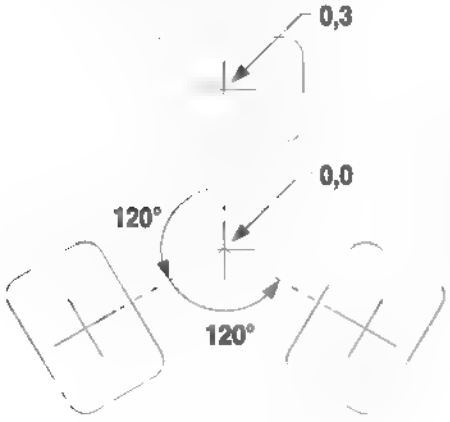


Figure 7-37

This program cuts a box pocket at the location 0,3 (line 0010). The program then rotates the orientation of the part by 120° (line 0020) and a second pocket is cut (line 0030). Line 0040 causes another rotation, and line 0050 cuts a third pocket. The results of this program are shown in Figure 7-37. Line 0070 resets the orientation of the part to its original position.

+ PGMSTOP The **PGMSTOP** command can be used in several different ways.

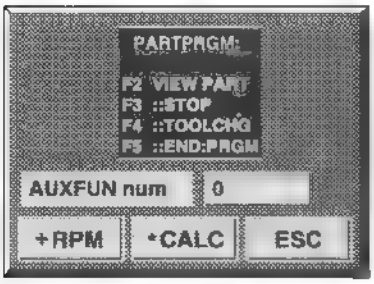


Figure 7-38

1) It is used to place a stop in the program, so that the program is halted until the operator restarts it by pressing the **START** button (**F3 STOP**).

2) It is used to stop the program so that a tool change can be made. If programmed with the tool number, the control will prompt the machine operator to change to the specified tool (**F4 TOOLCHG**).

3) It is used to end the program (**F5 END: PRGM**).

4) It can be used set a spindle speed, so that the program may be transferred to, and executed on, another Bridgeport control (**+ RPM**).

F2 VIEW PART The **F2** key in the **PGMSTOP** command will display the part preview mode. This does not enter an instruction into the program.

F3 STOP To use the **PGMSTOP** command to stop the program execution until the operator presses the **START** key again, press the **F3** key. The instruction **:: STOP** is placed in the program automatically.

F4 TOOLCHG To use the **PGMSTOP** command to stop the program, and prompt the operator for a tool change, press the **F4** key, and enter the number of the new tool in the TOOL field. The instruction **:: TOOLCHG T_** is placed in the program.

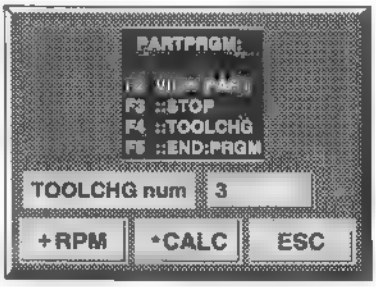


Figure 7-39

F5 END: PRGM To use the **PGMSTOP** command to end the program, press the **F5** key. The program instruction **:: END: PRGM** is automatically placed in the program.

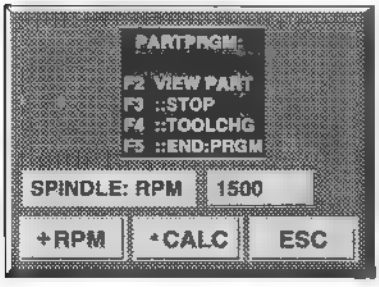


Figure 7-40

+ RPM To program a Spindle Speed select the **PGM STOP** command then press the **+ RPM** key. Enter the desired spindle speed. The instruction **:: SPINDLE ON S_** is placed in the program. This line is ignored by the EZ-TRAK SX, but is necessary at the beginning of the program if it is to be run on a BOSS control.

SLOT ARC

In the MDI mode the **.M SLOT** command can be used to create a circular slot. Note: this feature is available **only** in the MDI mode.

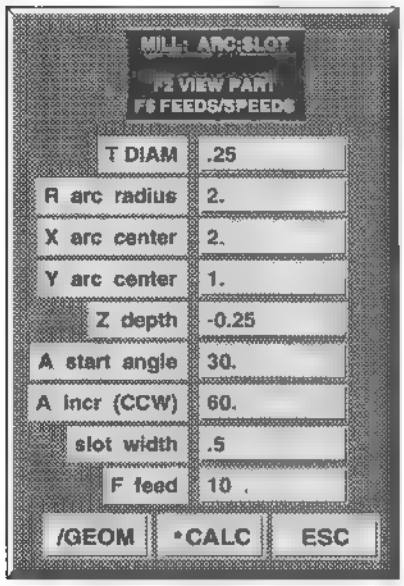


Figure 7-41

T DIAM	is the diameter of the tool
R arc radius	is the radius of the slot arc
X arc cntr	this is the X coordinate of the center point of the arc
Y arc cntr	this is the Y coordinate of the center point of the arc
Z depth	is the Z coordinate showing the milling depth
A start angle	is the start angle of the slot arc
A incr (CCW)	is the end angle of the slot arc
slot width	is the edge to edge width of the slot
F feed	this is the feedrate in inches per minute of the milling operation

For example, the instruction:

```
SLOT|ARC R2. XC1. YC1. Z-.25 A30 A60 P.5 D.25 F10.
```

will cut the arc shown in Figure 7-42, below.

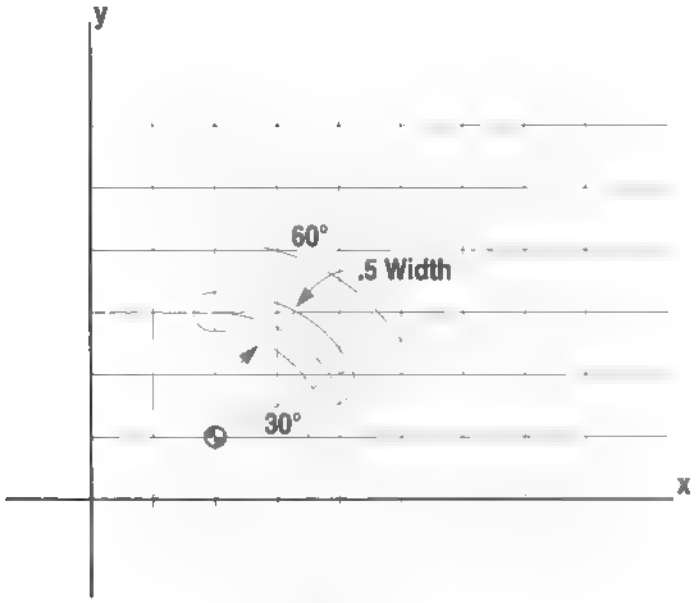


Figure 7-42

4 FACE

The **FACE** command face mills an area, designated by its length and width. In the MDI mode, this command also requires the starting position of the tool. Unlike the **FACE** command in the DO EVENT mode, the MDI FACE command does not require the tool to be at position and depth before the block is executed.

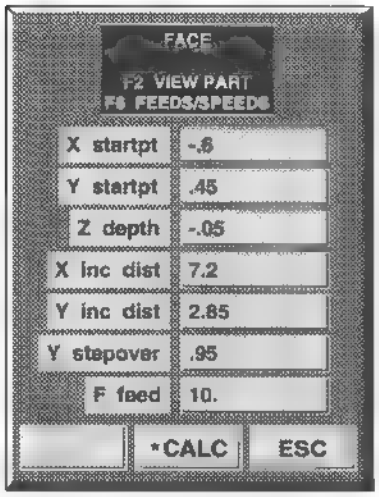


Figure 7-43

X startpt is the X coordinate of the start point for the FACE operation

Y startpt is the Y coordinate of the start point for the FACE operation

Z depth is the Z coordinate, giving the cut depth

X inc dist is the incremental distance to be milled along the X axis.

Y inc dist is the incremental distance to be milled along the Y axis.

Y stepover is the Y axis stepover.

For example, the programmed instruction:

```
0160 FACE|RECT X-.6 Y.45 Z-.05 X7.2 Y2.85 Y.95 F10.
```

will face mill the 6.0 x 3.75 block shown in Figure 7-44.

Figure 7-44

NOTE: It is possible to start at the top right hand corner of the face area, and proceed down and to the left. In this case, the X distance, and Y distance values are entered as negatives. The Y stepover value is always entered as an unsigned distance.

VIEW

The MDI commands have an additional feature, not found in the DO EVENT mode. Most of the MDI milling commands can display a preview of the part program geometry by pressing the **F2 VIEW PART** key while one of the instruction windows is shown on the screen. This displays a graphical preview of the part program geometry. Some program transformations (REPEAT, ROTATE, TRANSL) and the ramp-on and ramp-off moves created by the COMPON and COMPOFF commands are not displayed in this VIEW mode.

A typical **F2 VIEW PART** screen is shown below.

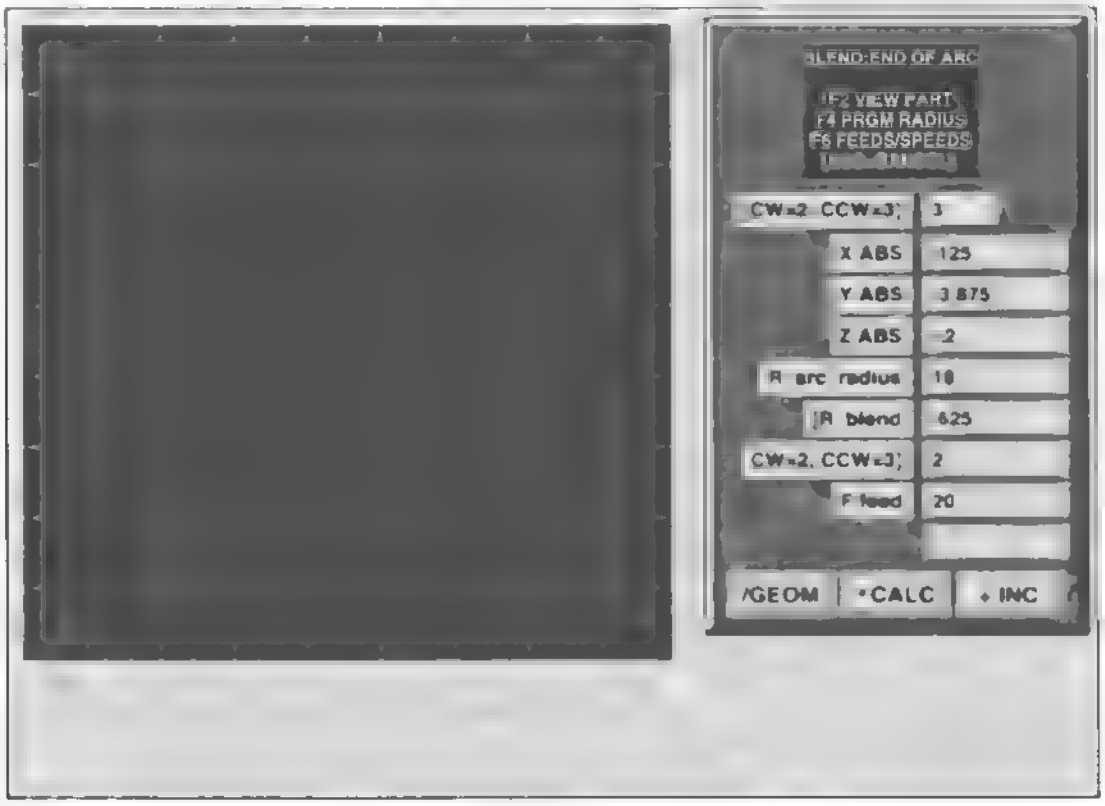


Figure 7-45

To view the actual tool path, and the complete part program, including translations, subprograms and repeats, the **PREVIEW** command in the **RUN** mode must be used. See Chapter 9 in this manual for more details on the **RUN** mode and Chapter 12 for more information on the **PREVIEW** mode.

UNDO If any line is programmed incorrectly, it can be deleted by pressing the **–UNDO** key. This automatically deletes the last programmed line. This can be used repeatedly.

CHAPTER 8
EDIT MODE

The EZ-TRAK has a dedicated Part Program Editor which is called from the BASIC OPERATIONS screen by pressing the **5** key. This is an intelligent editor and is capable of recognizing the format of each command in the part program. When a line is selected for editing, the line is re-displayed in the data fields used to program the line in the MDI programming mode.

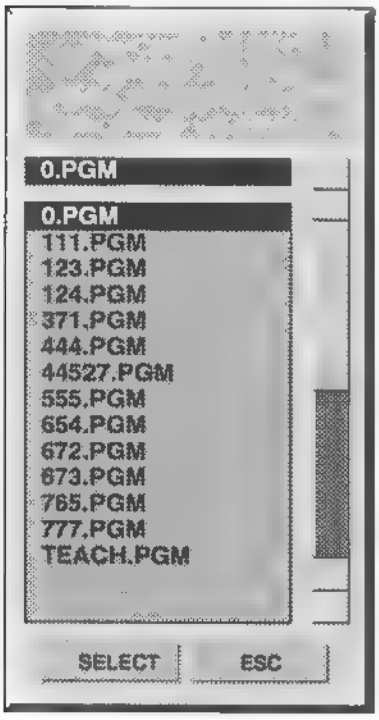


Figure 8-1

When the EDITOR is selected from the BASIC OPERATIONS screen, the screen displays a list of files that are currently available for editing, as shown in Figure 8-1.

A file is selected from this list by using the up and down cursor arrow keys to move the highlight bar to select the desired file.

When the file to be edited is highlighted, press the + key to select the file and load it into the EDITOR.

Pressing the **ESC** key while the list of editable files is shown on the screen aborts the call to the EDITOR and returns the display to the BASIC OPERATIONS screen.

The EDITOR also provides specific commands for inserting and deleting lines, renumbering the program instructions, and controlling the line numbers in the part program. Each command available in the EDITOR is listed in this chapter.

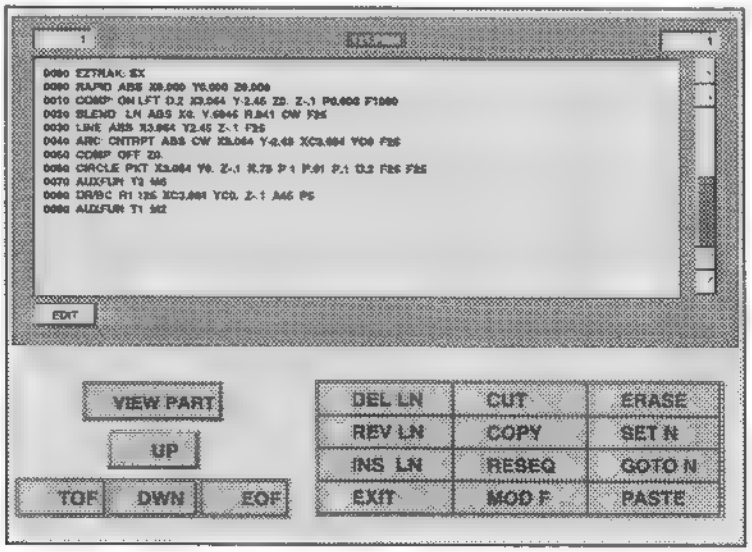


Figure 8-2

0 **EXIT**. The **0** key in the EDIT mode exits the EDITOR and prompts the user to save the edited program. The name can be changed at this point so that a new file is created, leaving the original file unchanged. The new program name can be typed in place of the existing name in the **PRGM** field. The file extension **.PGM** is added automatically.

+ SAVE. This key causes the program to be saved under the name listed in the **PRGM** field shown above. If this name is not changed, then the old file is replaced with the program just edited.

*** SAVE | RUN**. This command saves the program under the name in the **PRGM** field shown above, and loads the program into memory so that it can be executed.

– CANCEL. This command cancels the **EXIT** command and returns to the EDITOR without saving the part program.

/ VIEW PATH. This command saves the program, exits the **EDIT** mode, and displays the **VIEW** mode. The program can be previewed by using the commands described in chapter 12.

ESC=(EXIT). This command exits the EDIT mode without saving the part program. Any changes that were made during the EDIT mode session are not saved, and the program remains in its original condition.

/ **MOD F**. The / key in the EDITOR is used to modify the programmed feedrate in a group of lines. The screen displays prompts for **BEGIN at SEQNO**, **END at SEQNO**, and **modify F to**. All of the programmed feedrates in the text from the **BEGIN at SEQNO** and up to but not including the **END at SEQNO** line, will be changed to the modified feedrate value.

\+ **PASTE**. This command inserts the text from the temporary buffer COPY.TMP into the program **after** the current line. The buffer COPY.TMP is **not** destroyed after the text is pasted, so that the text may be pasted multiple times.

1 **INSERT LN**. Pressing the **1** key in the EDITOR calls the MDI programming screen so that lines can be inserted into the current program **after** the current line. Lines are inserted using the MDI mode by selecting the desired commands, and entering the necessary data for each line. The MDI mode remains active until the **0** key (**XIT INS**) is pressed. This key returns to the EDITOR. After returning to the EDITOR from the MDI mode it is a good idea to **resequence** the part program by pressing the **2** **RESEQ** key.

2 **RESEQ**. The **2** key in the EDITOR performs a **resequence** command on the part program being edited. The screen displays prompts for the **N,SEQNO** number (the line number of the first program line) and **N,INC** (the increment for each of the following line numbers). The part program is automatically renumbered when these two numbers are entered. Pressing **ESC** aborts the resequence command and returns to the EDITOR without affecting the program.

3 **GOTO N**. This command searches the program for the next occurrence of a designated sequence number. For instance, if **150** is entered, the cursor moves to line 150. GOTO works from the current cursor position down to the end of the program. It will not search backwards.

4 **REV LN**. This command is used to revise any line in the part program. Using the cursor arrow keys, place the cursor on the line to be revised. Then press the **4** (**REV LN**) key. The line is read, and broken down into the data fields that were used to create the operation. The data in each field of the command can be changed with a few exceptions. The nature of a command cannot be changed, e.g. a line with the M ARC operation cannot be changed to M LINE. This must be changed by deleting the offending line and then inserting a new line.

NOTE: the operator cannot change the context of the block of data. If the block was created as a MILL ARC by CENTERPT command it cannot be modified to a MILL ARC by RADIUS command. To make a command type change, delete the line and insert a new one with the desired context. Also note, that the first line in the part program, **0000 EZTRAK 1 MODE|INCH** cannot be edited.

5 **COPY**. The **COPY** command is used to copy a group of lines into a temporary buffer named COPY.TMP. The screen displays prompts for **BEGIN at SEQNO** (the number of the first line to be copied) and **END at SEQNO** (the line number of the last line to be copied). The line with the designated **END at SEQNO** will **not** be copied. **COPY** is use in conjunction with the **PASTE** command. NOTE that the buffer COPY.TMP will contain the last text copied such that it can be used as a "clipboard" - to paste data from one program into another.

6 **SET N**. This command is used to control the line numbers of any lines which are inserted into the part program by selecting the **1 INS LN** command. The screen displays prompts for **N,SEQNO** the first line number, and **N,INC** the increment of each following line number.

7 **DEL LN**. This command deletes the line on which the cursor currently appears. It is a good idea to use the **2 RESEQ** command after deleting one or more lines from a part program. DO NOT DELETE THE FIRST LINE OF THE PART PROGRAM.

8 **CUT**. The **CUT** command is similar to the **COPY** command. A group of lines is copied to the temporary buffer COPY.TMP; however, when the selected lines are copied, they are also deleted from their original location. This command is useful for moving a group of lines from one section of a program to another.

9 **ERASE**. The **ERASE** command is used to delete a group of lines at one time. The screen displays prompts for **BEGIN at SEQNO** (the number of the first line to be deleted) and **END at SEQNO** (the number of the last line to be deleted). The line with the designated **END at SEQNO** will **not** be deleted.

- **VIEW PART** The **VIEW PART** command displays the part program geometry on the screen. The operator is prompted for the first line number to be viewed, and the last number to be viewed. When the part is viewed, a prompt appears to either **EXIT** the VIEW PART mode, or **REVEIW**. The **REVIEW** command allows the user to enter new line numbers to view the part again.

Figure 8-3

<right arrow> EOF This command moves the cursor to the last line of the part program.

<left arrow> TOF This command moves the cursor to the first line of the part program. This is useful for positioning the cursor before using the **GOTO N** command.

<up arrow> Up This key moves the cursor upward from the current line to the previous line on the screen. This is useful for positioning the cursor before using the **PASTE** command to insert text that has been cut or copied to the COPY TMP buffer.

<down arrow> Down This key moves the cursor downward from the current line to the following line on the screen. This is useful for positioning the cursor before using the **PASTE** command to insert text that has been cut or copied to the COPY TMP buffer.

CHAPTER 9
RUN MODE

INTRODUCTION

The **RUN** mode is used to execute a pre-loaded program. The program can be executed in **BLOCK** mode one instruction at a time with machine stops between each instruction, or it can be executed in **AUTO** mode with continuous operation. The **RUN** command is chosen from the BASIC OPERATIONS screen by pressing the + key.

THE RUN SCREEN

When the **RUN** command is selected the screen displays:

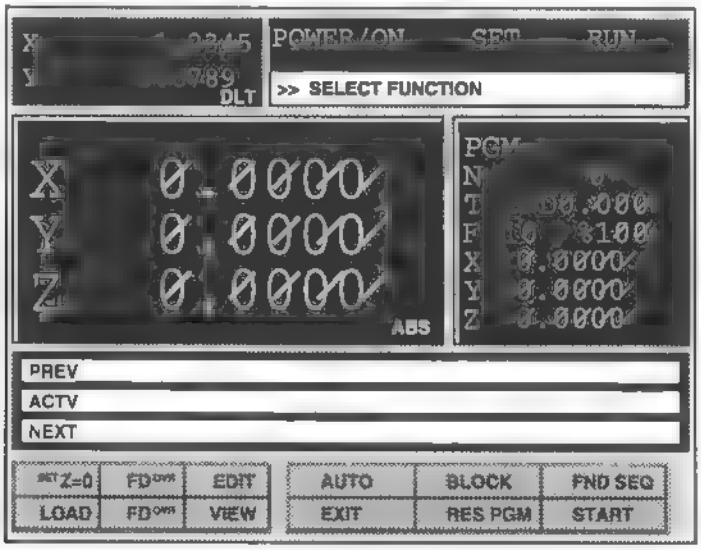


Figure 9-1

KEY FUNCTIONS

0 EXIT The **EXIT** command leaves the **RUN** mode and returns to the BASIC OPERATIONS screen.

1 AUTO The **AUTO** command sets the loaded program to be run in continuous operation. The program stops for Z axis adjustment, for programmed stops, or tool changes. The program run begins when the **START** key is pressed.

2 BLOCK The **BLOCK** commands sets the loaded program to be run in single step mode. Each line of a program is executed, and the program is halted until the **START** key is pressed. The program run begins when the **START** key is pressed.

3 **FND SEQ** This command searches the active part program for a specific sequence number or tool change command The **FND SEQ** command displays a window on the screen as shown in Figure 9-2.

Figure 9-2

Press the **+** key to find a sequence number in the active part program, or press the * key to find a tool change by the tool number. Once the sequence number or tool change is found the program will begin execution at that line.

Press the **ESC** key to exit to the RUN mode.

. **RES PGM** This command is used to reset the active program back to the beginning. The program must be reset before it can be run again.

\+ **START**. The **START** command begins program execution in either the **BLOCK** mode or the **AUTO** mode. The **START** key is also used to restart the program after it has stopped for drilling, Z axis adjustment, or a programmed stop.

<cursor UP> <cursor DOWN> FDR OVR The FD^{OVR} commands are used to override the programmed feedrate. The <up arrow> key raises the programmed feedrate by 5%. The <down arrow> key lowers the programmed feedrate by 5%. The feed override amount is shown as a percent on the right side of the screen.

<cursor LEFT> LOAD The **LOAD** command is used to choose a part program to run. When a program is chosen, it becomes the active program in memory.

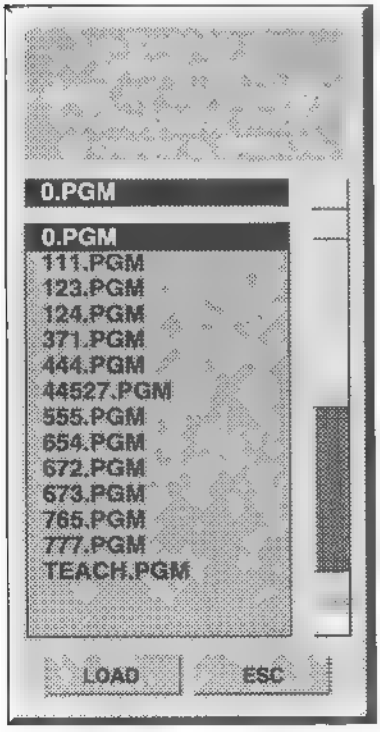


Figure 9-3

When the **LOAD** command is selected, the file list shown in Figure 9-3 is shown on the screen. The <up arrow> and <down arrow> cursor keys can be used to scroll through the list of files. Press the **+ LOAD** key when the desired file is highlighted.

In the file list, only **.PGM** files are shown. To display a list of the G-Code **.TXT** files, press the **F4** key. The list shows only the **.TXT** files that are on the EZ-TRAK.

To list the files that are on the 3.5 inch diskette in the disk drive, press the **F5** key. At first, on the **.PGM** files are shown. Press the **F4** key to list the **.TXT** files.

The <left arrow> and <right arrow> cursor keys can also be used to move through the list of files very quickly. The <right arrow> key advances downward through the file list one page at a time. The <left arrow> key moves upward through the list one page at a time.

Press the **ESC** key to exit the **LOAD** command without loading a file.

<cursor RIGHT> VIEW This enables previewing the part-program by simulating the cutter path on the display screen. For more information on the **VIEW** mode, see Chapter 12 in this manual.

/ **set Z=0** This command resets the **Z** axis to zero. This is used to determine where the top of the part is. Before executing a program, bring the tool down so that it touches the top of the part, then press the / key to reset the **Z** axis. This should also be done each time the tool is changed during the execution of the program.

* **EDIT** This key is used to edit the currently loaded part program.

DLT Display When the **RUN** mode is selected, the EZ-TRAK logo in the upper left corner of the screen changes to show an X and Y value. This display has the letters **DLT** in the lower right corner. These values show the Distance Left to Travel for the current instruction, shown in the **ACTV** line in the lower portion of the screen. These values should not be confused with coordinates, nor programmed X and Y values.

CHAPTER 10
FILE UTILITIES

The EZTRAK provides you with a complete set of file utilities which allow you to copy data to and from the EZTRAK's internal drives, floppy diskettes, or directly from another computer.

Your particular machine will show you either of two different sets of commands, depending on how many disk drives are installed on your machine.

- If you have *either* a hard disk *or* a flashcard drive—but not both—the Utilities on your machine are described in section 10.1.

- If you have *both* a hard disk and flashcard drive, your Utilities are described in section 10.2.

- The commands to send and receive files through the RS-232 (serial) port are identical in the two versions; they are described in section 10.1

For either configuration, select 9 from the Basic Operations screen.

In the following sections and menus, the Utilities commands use three different words to describe the different disk drives :

- FLOPPY DISK always refers to the 3.5-inch disk drive located on the back of the cabinet (the A: drive). It uses the same 3.5-inch diskettes as most personal computers.

- If a flashcard drive is installed, it is referred to as EZTRAK; otherwise, EZTRAK refers to the hard disk.

- If your machine has both a flashcard drive and a hard disk, the hard disk drive is called BACKUP HARD DISK.

The Utilities commands use two different words to describe types of files:

- "EZTRAK files" are program files that have been created with the EZTRAK MDI mode. Their filename always ends in .PGM; for example, the program "12345" is in a file called "12345.PGM" .

- "OTHER files" are program files written in G-code. Generally, these are program files which have been created in an off-line programming system, such as a CAM program. To be used on your machine, their filename must end with .TXT; for example, the

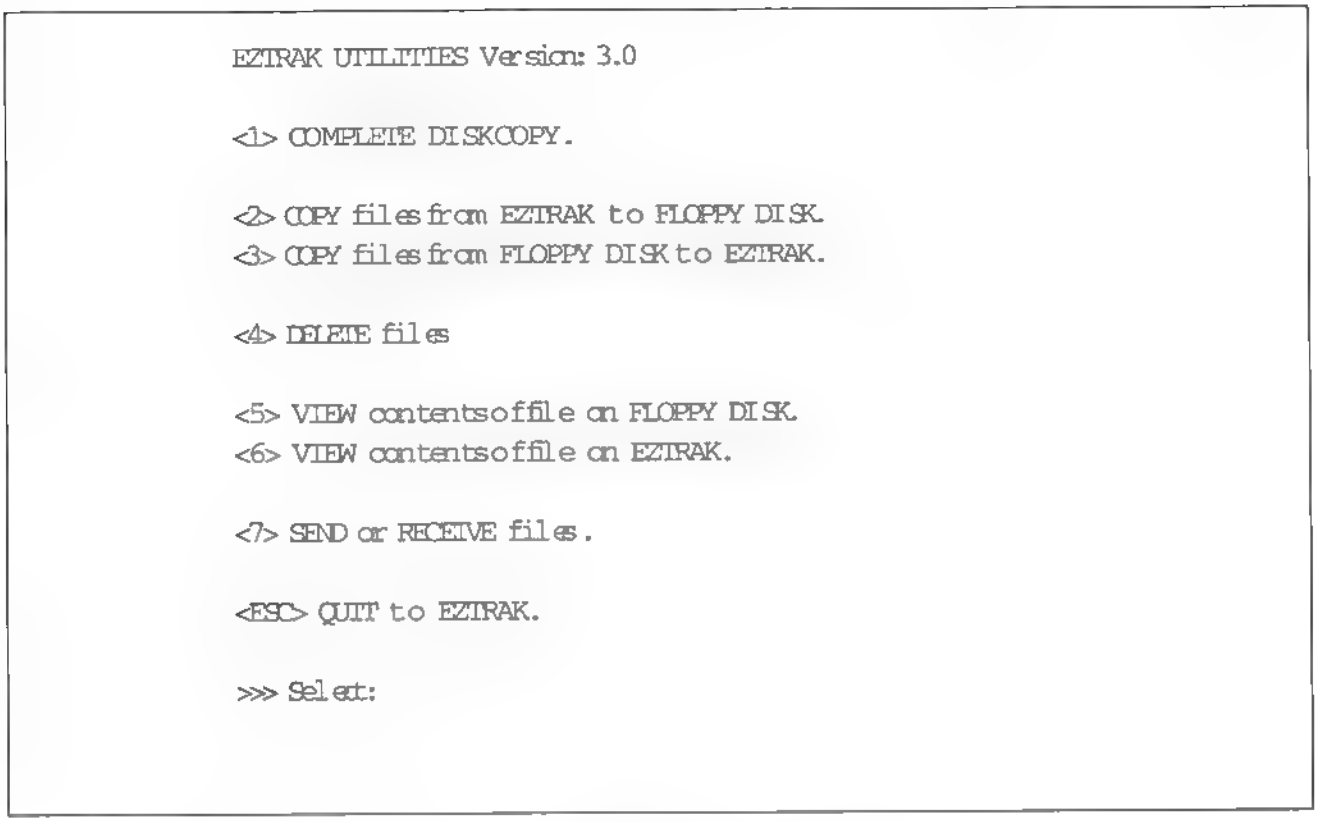


Figure 10-1

program "12345" would be in a file called "12345.TXT" .

10.1 Machines with only one internal drive

If your EZTRAK has only one internal drive (in other words, either a hard disk or a flashcard drive, but not both), when you press the 9 key you will see the screen shown in Figure 10-1.

- In the screen samples shown in this section, the "EZTRAK" drive refers to either the hard disk drive or the flashcard drive, whichever is installed in your system. If you have both drives, see section 10.2.

The following commands are available:

<1> COMPLETE DISKCOPY
Use this command to copy one entire floppy diskette onto another. If you are copying the EZTRAK system diskette, make sure the system diskette is locked before copying; this will prevent it from being accidentally overwritten. To lock a diskette, slide the small tab on the back of the diskette so that the hole is uncovered. If you need to use this diskette to restart

the EZTRAK, remember to slide the tab back so that the hole is covered up.

<2>, <3> COPY FILES

These two menu options let you copy files back and forth between the EZTRAK internal disk and a floppy diskette. Program files and related data are usually stored on the machine's internal disk so that they are easily available; on the other hand, a permanent copy is usually stored on a floppy diskette to be used as a backup copy. Option 2 lets you copy files from the EZTRAK internal disk to a floppy disk; use option 3 to copy files in the other direction (from a floppy onto your internal disk). A 3.5-inch diskette must be in the disk drive (A) before selecting either command, or you will get an error message.

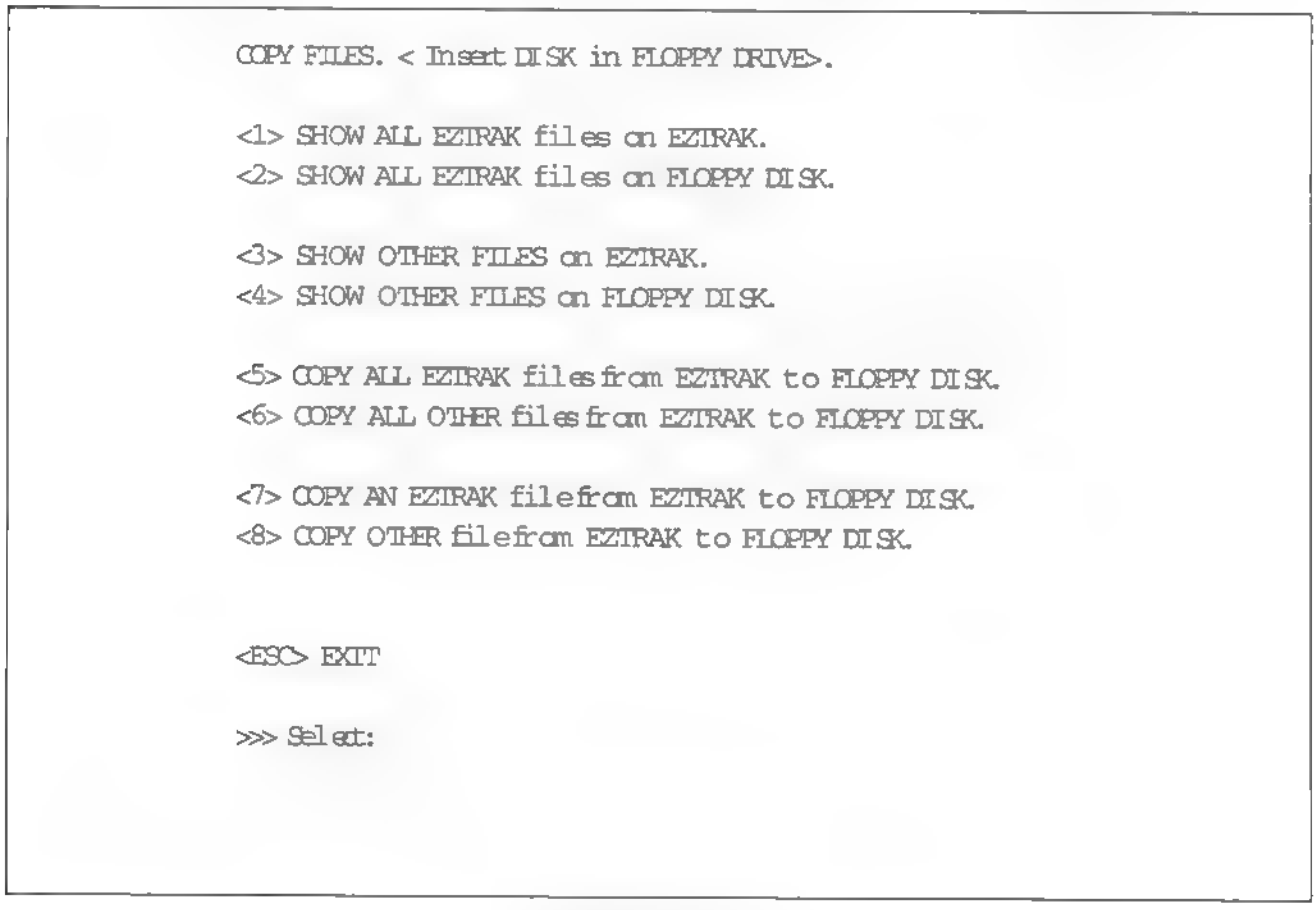


Figure 10-2

When Option 2 is selected, the following choices are shown on the screen (see Figure 10-2):

- Selecting 1 will display a list of all the EZTRAK files on the internal disk; selecting 2 displays a list of all such files on the floppy diskette. (An EZTRAK file is a program file that has been created directly on the EZTRAK machine; its filename will end with .PGM.)

- Selecting 3 will display a list of OTHER files on the internal disk, these will be program files that have *not* been created on the EZTRAK machine, and whose filenames will end in .TXT. Selecting 4 lists all of these files on the floppy diskette.

- Selecting 5 copies *all* of the PGM files from the internal disk to the floppy; selecting 6 copies all of the TXT files.

- Pressing the 7 key lets you choose one PGM file, by name, and copy it to the floppy disk; 8 lets you copy one TXT file in the same way.

Pressing the e key exits this menu, and returns to the main Utilities screen.

All of the above commands copy data from the internal disk to a floppy diskette; if you want to move files from a floppy diskette to the EZTRAK internal disk, select **3** from the Utilities Main Menu; you will see the screen shown in Figure 10-3.

As you can see, it is identical to the screen shown in Figure 10-2, except that options 5–9 copy data in the other direction: from the floppy diskette to the internal disk. Use these

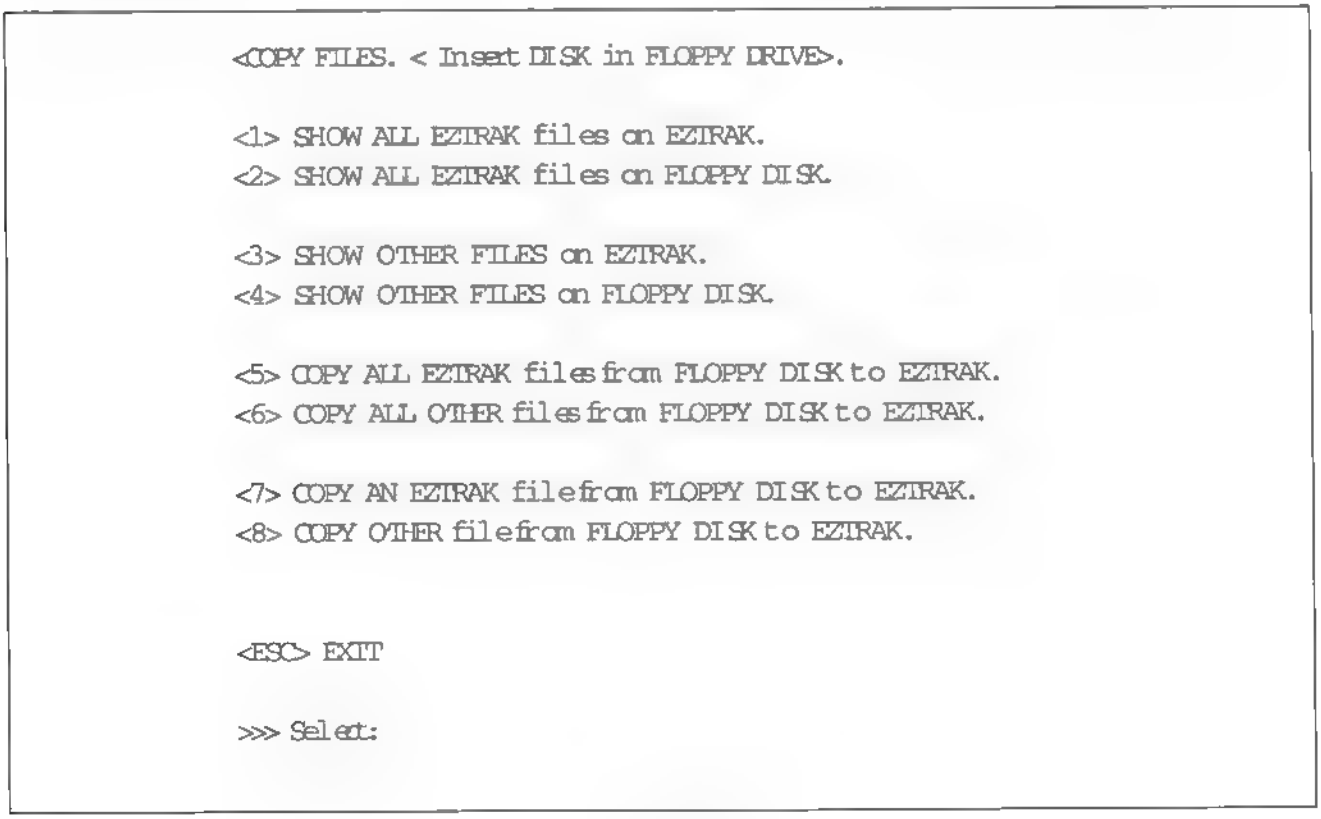


Figure 10-3

```
DELETE FILES. < Insert DISK in FLOPPY DRIVE>.

<1> SHOW ALL EZTRAK files on EZTRAK.
<2> SHOW ALL EZTRAK files on FLOPPY DISK.

<3> SHOW OTHER FILES on EZTRAK.
<4> SHOW OTHER FILES on FLOPPY DISK.

* <5> DELETE ALL EZTRAK files on EZTRAK or FLOPPY DISK.
* <6> DELETE OTHER program files on EZTRAK or FLOPPY DISK.

* <7> DELETE AN EZTRAK file from EZTRAK or FLOPPY DISK.
* <8> DELETE OTHER program files from EZTRAK or FLOPPY DISK.

<ESC> EXIT

>>> Select:
```

Figure 10-4

commands as described above.

<4> DELETE FILES Option 4 from the Utilities main menu is used to delete files from either the floppy diskette or the internal disk. Selecting it displays the options shown in Figure 10-4.

- Options 1–4 work the same way as in the Copy Files menus; they display lists of PGM and TXT files from the internal disk and floppy diskette.

- Select option 5 to delete ALL PGM files from the EZTRAK internal disk or Floppy Disk. After you press the 5 key, it will ask you to specify the drive: (0) EZTRAK or (1) FLOPPY DISK. Hit the minus key <–> to delete ALL PGM files from the drive you have selected. Option 6 works the same way, but will delete ALL TXT (or non-PGM) files from the selected disk.

- Options 7 and 8 work the same as 5 and 6 above, but allow you to delete an INDIVIDUAL EZTRAK (PGM) FILE (7), or INDIVIDUAL TXT FILE (8) file from the disk you select.

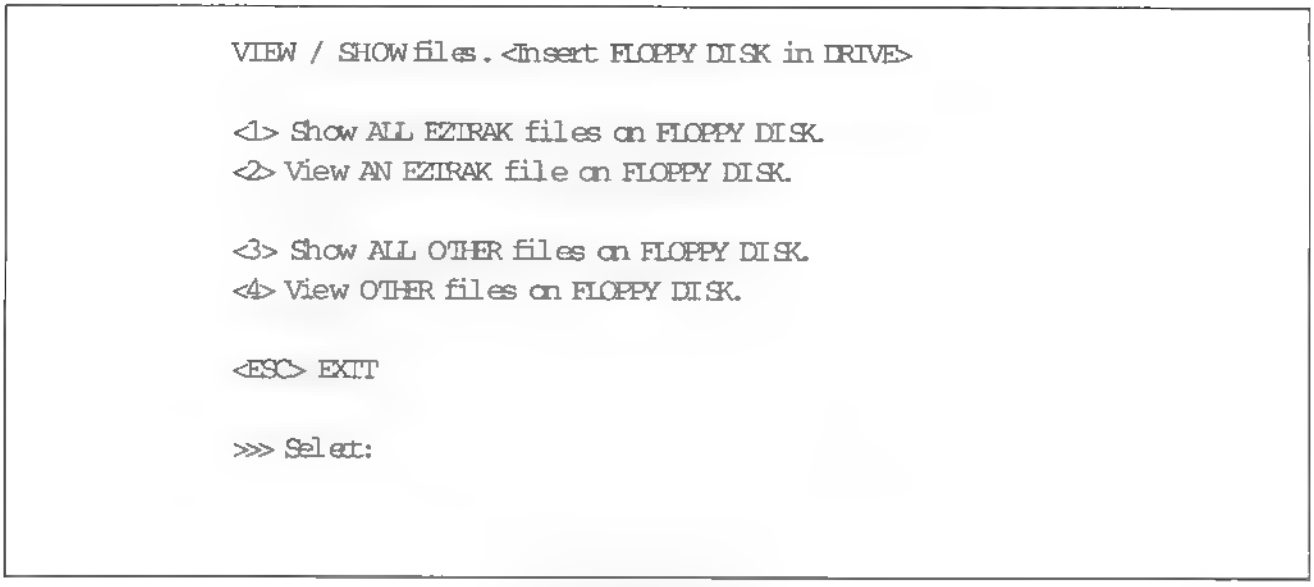


Figure 10-5

Pressing the e key exits this menu, and returns to the main Utilities screen.

<5>, <6> VIEWING A FILE

Use these utilities to see what is in a file. Selecting this option will only display the file on the screen; you cannot edit or make any changes to the file. Use 5 to view files on a floppy diskette, and 6 for files on the internal disk.

When 5 is selected, you will see the choices shown in Figure 10-5 (option 6 would be identical, except that "EZTRAK" replaces "Floppy Disk.").

- Pressing the 1 key lists all the PGM files that are on the floppy disk in the disk drive.
- If you press the 2 key, it will let you select a PGM file to display.
- The 3 key lists all the TXT files that are on the floppy disk in the disk drive.
- If you press the 4 key, it will let you select a TXT file to display.

As always, pressing the e key exits this menu, and returns to the main Utilities screen.

<7> SEND OR RECEIVE FILES

EZTRAK can also share data and download programs from other computers (such as a computer running EZ-CAM software) or another EZTRAK machine. Data is transferred via a cable connected to the machines' serial ports (also known as RS-232 ports). Bridgeport Machines EZ-CAM adapter cable (part no. 1940515) and Universal Communications cable (part no. 1940303) can be used for this purpose.

Communication Protocols

After selecting 7 from the Utilities main menu, you will see the menu shown in Figure 10-6. Before the two machines can communicate with each other, you need to choose a communications protocol; each machine needs to be set to the same protocol so that each machine can understand the other's instructions. EZTRAK supports three protocols: EZ-LINK, Ymodem, and ASCII.

If you wish to use Ymodem or ASCII data transfer, select 2 or 3, and skip to "**Sending and receiving files**" below.

EZ-LINK is a special communications protocol used by Bridgeport Machines equipment and software. Select 1 to use this protocol. The EZTRAK system diskette contains a program called EZUTILS.EXE; it can be run on any remote MS-DOS computer

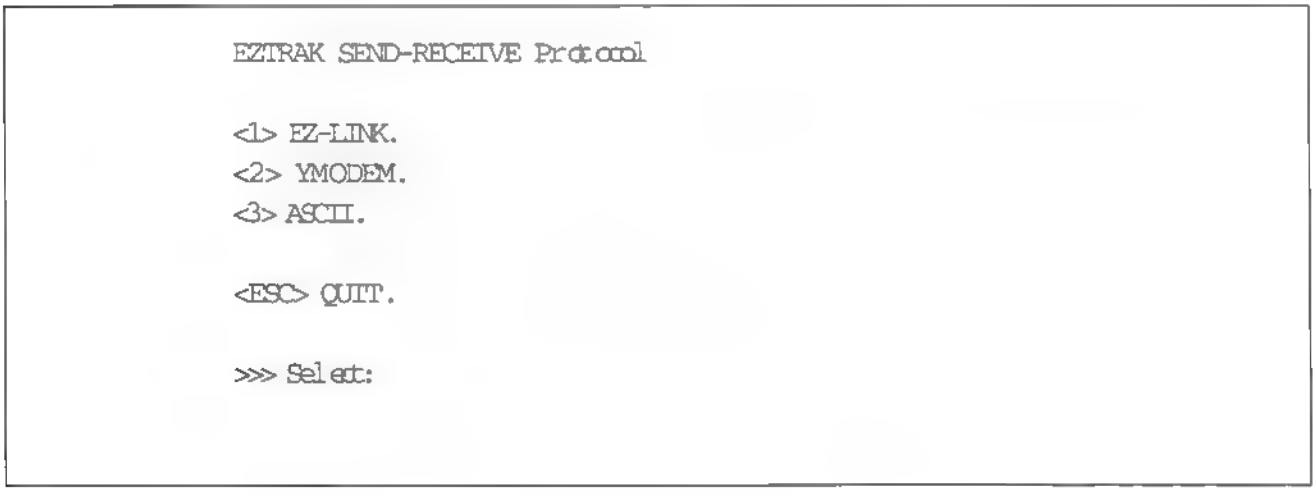


Figure 10-6

```
EZ-Link CONNECTED To

<1> EZTRAK.
<2> EZ-CAM.
<3> EZ-FILE.

<ESC> QUIT.

>>> Select:
```

Figure 10-7

(using COM1 only), and supports all three protocols.

EZ-LINK protocol

If you select EZ-LINK, you will need to specify some additional information. First, you must tell the communications software what kind of device you will be communicating with. When you select the EZ-LINK protocol, you will see the screen shown in Figure 10-7.

The options are 1, another EZTRAK machine; 2, a computer running EZ-CAM software; or 3, a computer running EZ-FILE software.

EZ-LINK thinks of one device as the "master" device, and the other as the "slave." All of the commands to transfer files are issued at the master computer; the slave computer can only receive commands. EZ-LINK assumes that the EZTRAK is the master and the other device is the slave—unless the other device *is* another EZTRAK machine. Therefore, if you select 1 from the above menu, you will see the following menu (Figure 10-8), where you tell EZ-LINK whether your machine is the master or the slave:

```
EZ-Link MASTER \ SLAVE:

<1> MASTER.
<2> SLAVE.

<ESC> QUIT.

>>> Select:
```

Figure 10-8

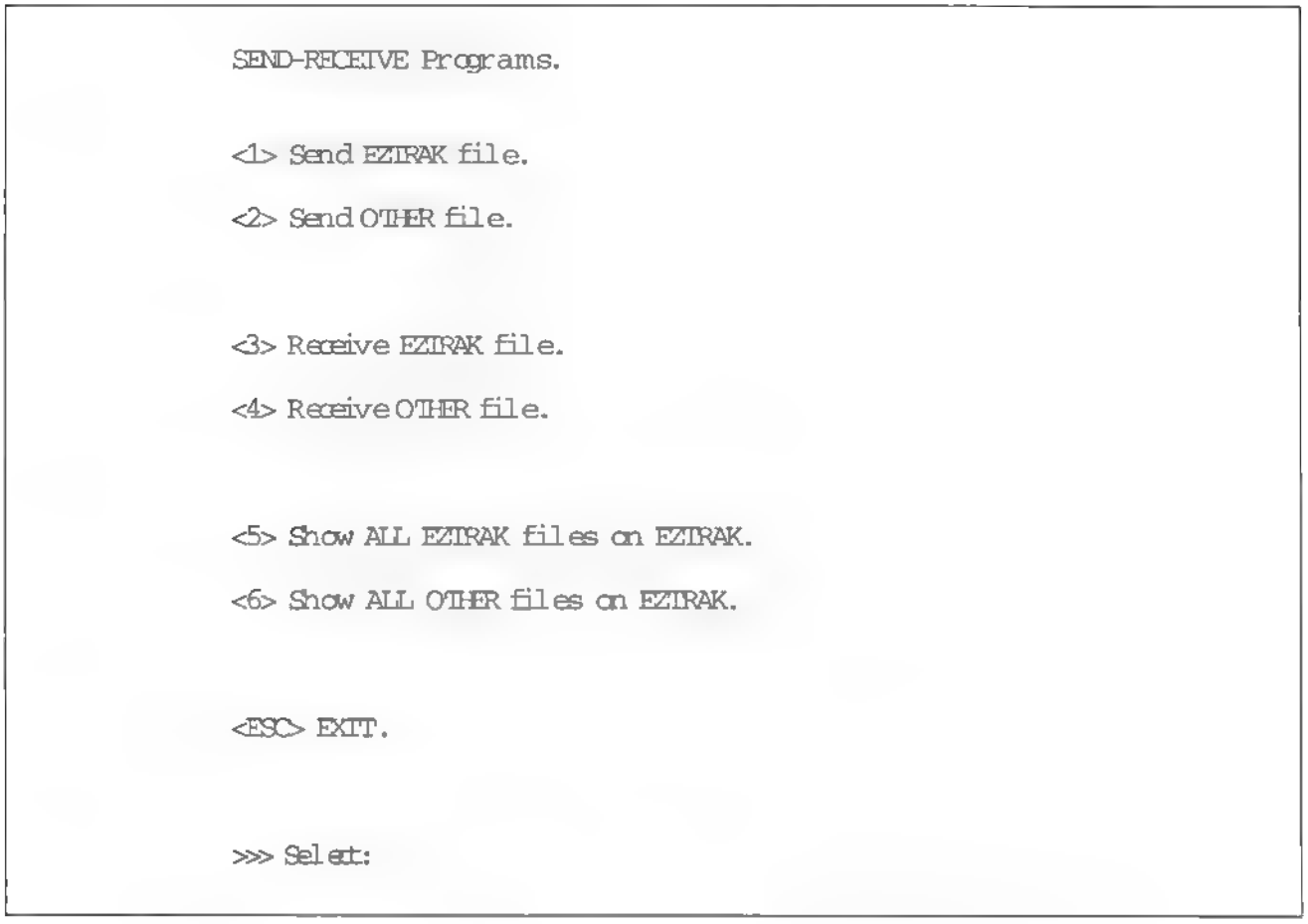


Figure 10-9

Be sure you coordinate your settings with the other EZTRAK machine.

Sending and receiving files

When all of your communication protocols have been set, you are ready to begin sending or receiving data, and you will see the menu shown in Figure 10-9. Note that if you are using EZ-LINK protocol, the slave device must be set on-line first, and the master device second. If the slave device is not yet on-line, do so now, before selecting one of the following commands.

Use option 1 to send a EZTRAK (i.e., PGM) file to another device, and 2 to send a TXT file. Use 3 to receive a PGM file, and 4 to receive a TXT file. Use 5 and 6 to view directories of files of each type on your local EZTRAK internal disk.

After selecting any of 1–4, your EZTRAK machine will ask you for the name of the file to send or receive (as appropriate); if you are receiving the file, this is the name that it will be stored under on your internal disk. At this point, if you are receiving a file, the operator of the remote computer should select the file to be transmitted.

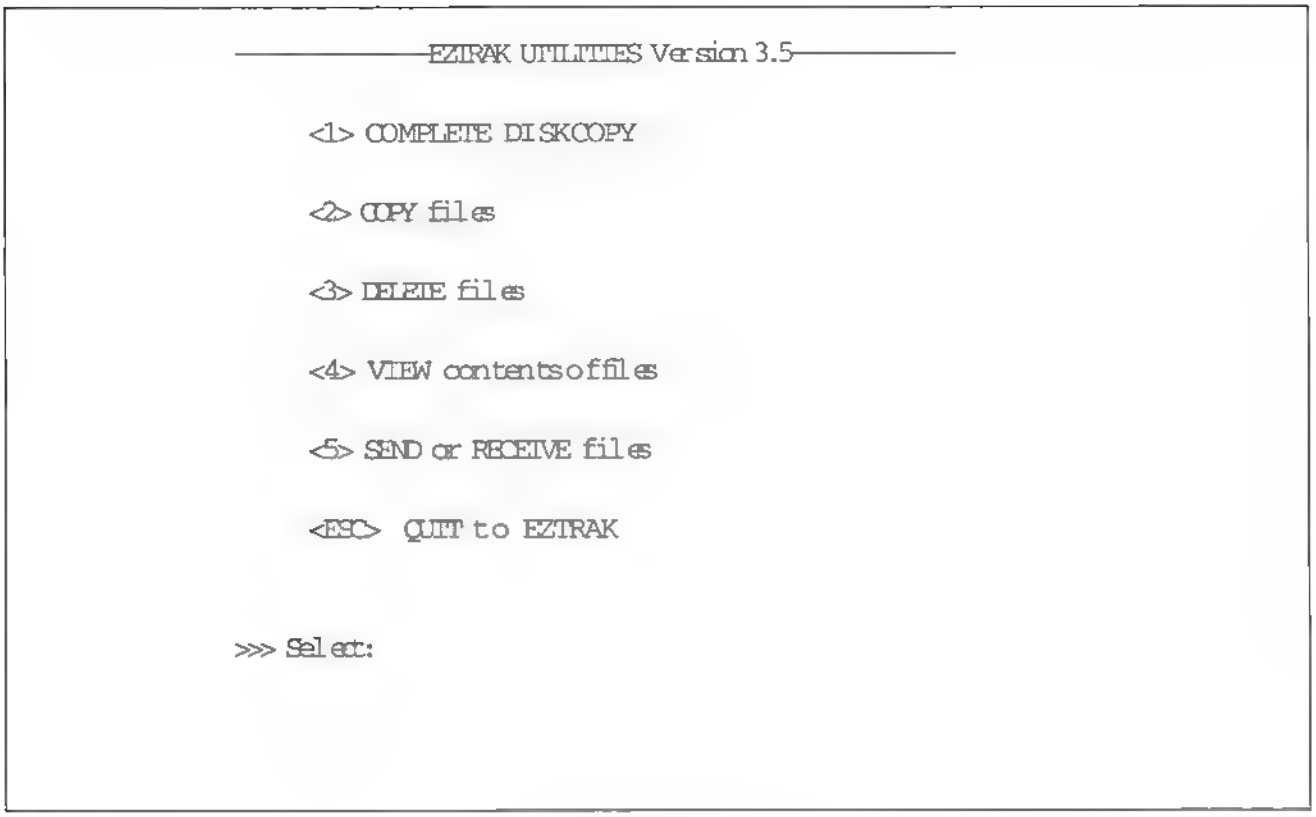

EZTRAK UTILITIES Version 3.5
<1> COMPLETE DISKCOPY
<2> COPY files
<3> DELETE files
<4> VIEW contents of files
<5> SEND or RECEIVE files
<ESC> QUIT to EZTRAK
>>> Select:

Figure 10-10

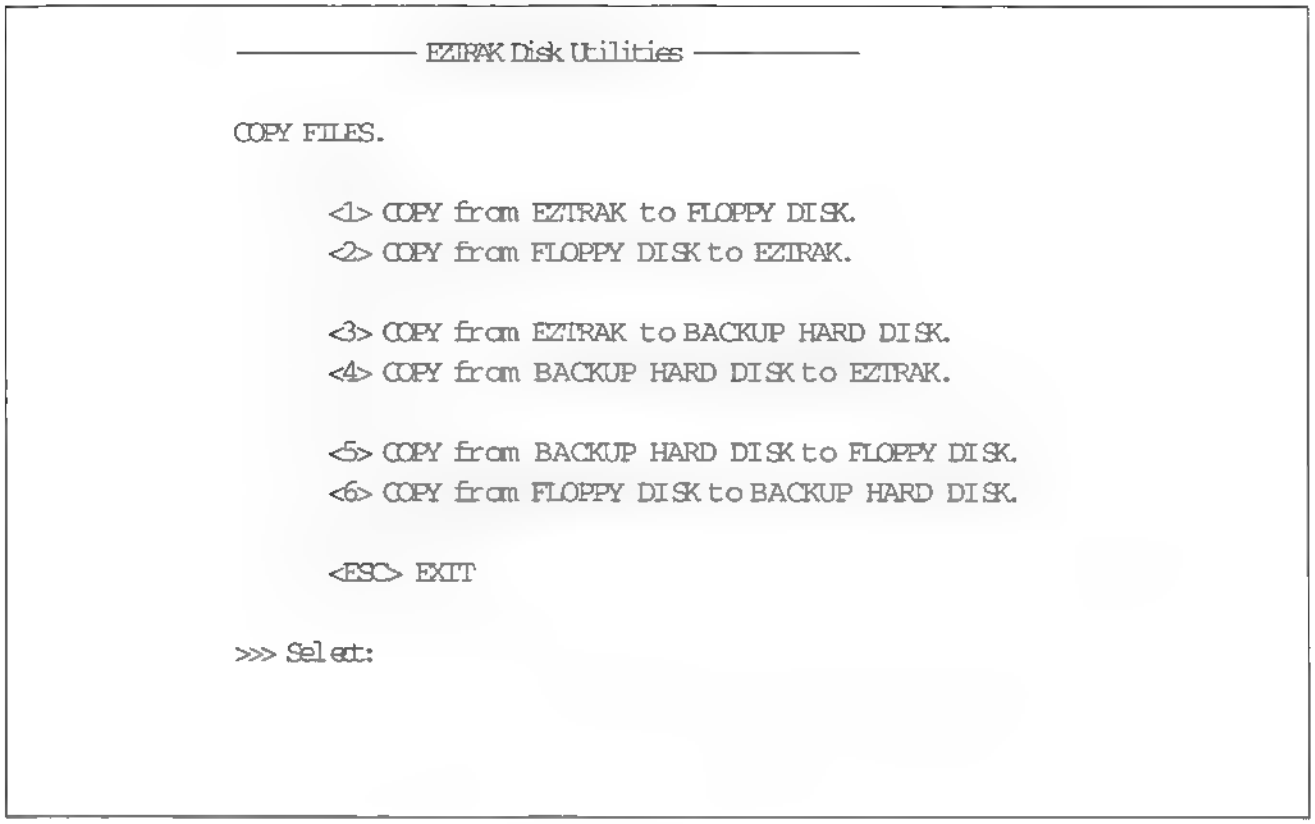


Figure 10-11

10.2 Machines with BOTH flashcard and hard disk

If your EZTRAK has two internal drives (in other words, both a back-up hard disk and a flashcard), when you press the 9 key you will see the screen shown in Figure 10-10. The following commands are available:

<1> COMPLETE DISKCOPY
Use this command to copy one entire floppy diskette onto another. If you are copying the EZTRAK system diskette, make sure the system diskette is locked before copying; this will prevent it from being accidentally overwritten. To lock a diskette, slide the small tab on the back of the diskette so that the hole is uncovered. If you need to use this diskette to restart the EZTRAK, remember to slide the tab back so that the hole is covered up.

<2> COPY FILES
Use this menu option to copy files between the hard disk, flashcard and, floppy drive. When you select this command, you will see a menu like that shown in Figure 10-11; the different options let you copy files to and from any of the three possible drives, in either direction.

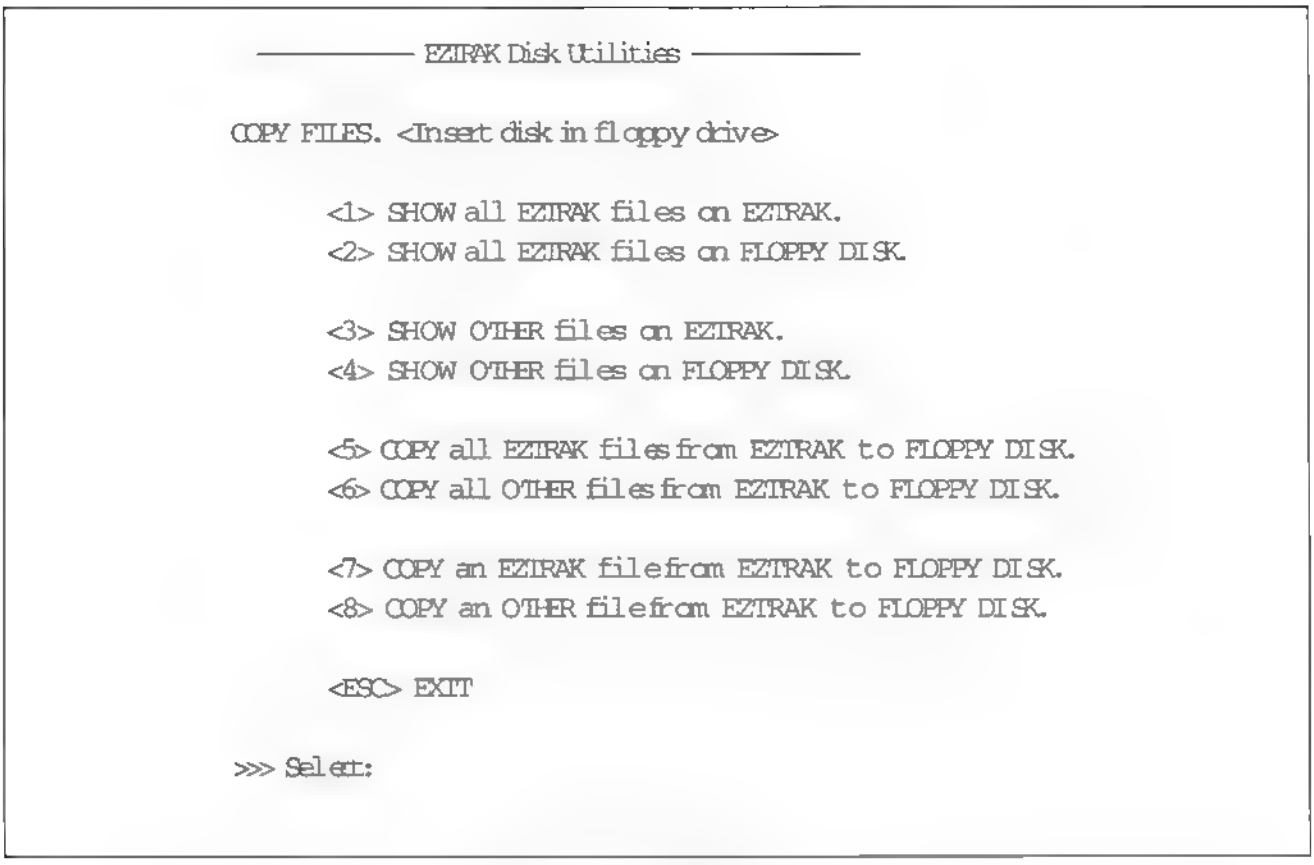


Figure 10-12

- Select options 1 and 2 to copy files to and from the flashcard and a floppy diskette.
- Select options 3 and 4 to copy files to and from the flash card and the hard disk.
- Select options 5 and 6 to copy files to and from the hard disk and a floppy diskette.

Pressing the e key exits this menu, and returns to the main Utilities screen.

After choosing the source and destination of your files, you will see a screen similar to the one in Figure 10-12. It lets you specify which file or files you want to copy.

- Options 1 and 2 show you a list of all the EZTRAK files on the source and target drives. These are files with MDI program commands (their names end with .PGM).

```
———————— EZTRAK Disk Utilities ————————

DELETE FILES.

     <1> SHOW all EZTRAK files on EZTRAK.
     <2> SHOW all EZTRAK files on FLOPPY DISK.
     <3> SHOW all EZTRAK files on BACKUP HARD DISK.

     <4> SHOW OTHER files on EZTRAK.
     <5> SHOW OTHER files on FLOPPY DISK.
     <6> SHOW OTHER files on BACKUP HARD DISK.

     <7> DELETE ALL EZTRAK files on EZTRAK, BACKUP HARD DISK, or FLOPPY DISK.
     <8> DELETE ALL OTHER program files on EZTRAK, FLOPPY DISK, or BACKUP HARD DISK.

     <9> DELETE an EZTRAK file from EZTRAK, FLOPPY DISK, or BACKUP HARD DISK.
     <0> DELETE OTHER program file from EZTRAK, FLOPPY DISK, or BACKUP HARD DISK.

     <ESC> EXIT

>>> Select:
```

Figure 10-13

- Options 3 and 4 show you a list of all the G-code program files on the source and target drives; these program files have names ending in .TXT.

- Use options 5 and 6 to copy all .PGM or .TXT files that you just listed.

- Use options 7 and 8 to copy just one of the files you listed. After pressing 7 or 8 to select which type of file you want to copy, EZTRAK will wait for you to type in the file name; since you do not have any letters on the keyboard, just type in the name without the ".PGM" or ".TXT".

Note that copying a file to either the flashcard or the hard disk does *not* mean that you can run it right away; you still need to use the Load command in Run mode as described elsewhere in this manual.

<3> DELETE FILES

Option 3 from the Utilities main menu is used to delete files from either the floppy diskette, the flashcard, or the hard disk. Selecting it displays the options shown in Figure 10-13.

- Options 1–3 displays lists of all PGM files from each of the drives.
- Options 4–6 display lists of TXT files from each of the drives.
- Options 7–0 let you delete some or all of the files.

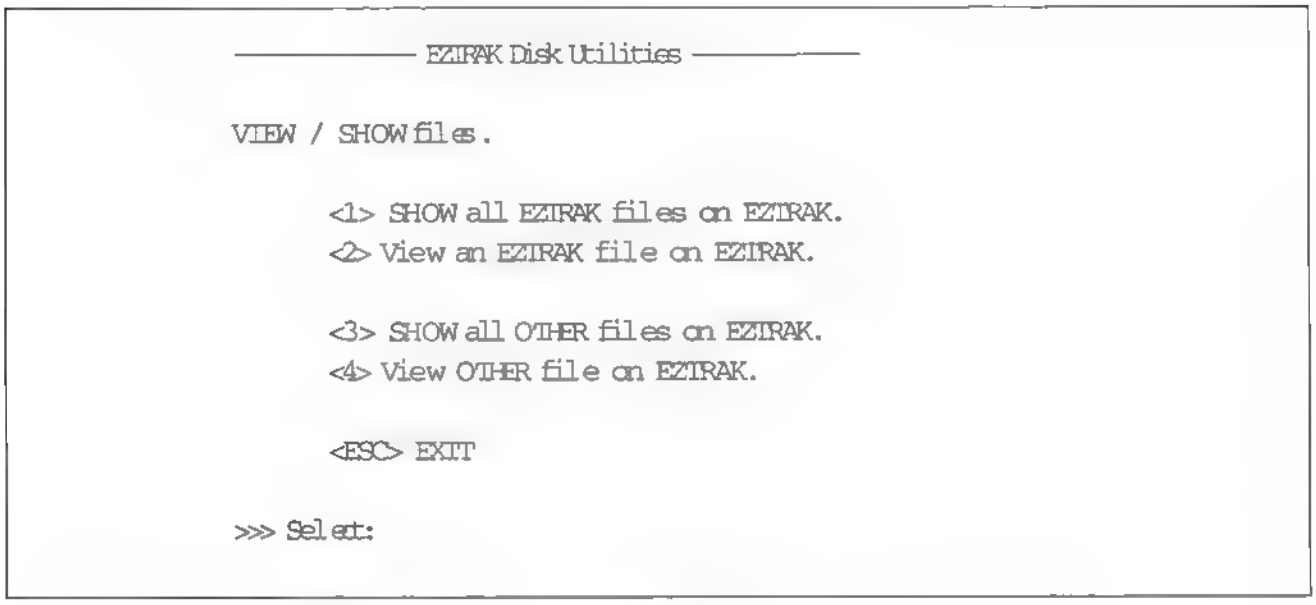


Figure 10-14

- Select option 7 to delete *all* of the PGM files on any one of the drives.
- Select option 8 to delete *all* of the TXT files from either of the drives.
- Option 9 lets you delete a single PGM file from any of the drives by typing in its name.
- Option 0 lets you delete a single TXT file from any of the drives.

After pressing any of 7–0, you need to specify the drive from which the file is to be deleted:

```
PRESS 0 FOR EZTRAK, 1 FOR FLOPPY DISK, AND 2 FOR BACKUP HARD DRIVE.
```

Enter 0, 1, or 2 to select the proper drive.

<4> VIEWING A FILE

Use these utilities to see what is in a file. Selecting this option will only display the file on the screen; you cannot edit or make any changes to the file. After pressing <4>, the machine will ask you to select a drive to look at:

```
PRESS 0 FOR FLOPPY DISK, 1 FOR EZTRAK, AND 2 FOR BACKUP HARD DRIVE.
```

Enter 0, 1, or 2 to select the proper drive. You will then see a screen similar to Figure 10-14, asking you whether you want to view a PGM (EZTRAK) or G-code (OTHER) file.

- You can choose to view all files, or just a single one. The only difference is that options 1 and 3 will show you a list of all the files, which you can select one by one if you choose.

As always, pressing the e key exits this menu, and returns to the main Utilities screen.

<5> SEND OR RECEIVE FILES

Use these commands to send and receive files through the EZTRAK's RS-232 (serial) port. They are described in the previous section (10.1) under option 7.

- If you have both the flashcard *and* a hard disk on your system, the files to be transferred must be on the flashcard.

CHAPTER 11
TEACH MODE

INTRODUCTION

The **TEACH** mode of the EZ-TRAK is a simple way of saving a part program as it is performed manually. The operator cuts the part manually, using the EZ-TRAK in the POWER OFF MANUAL mode, and saves a point at the end of each milling move. The EZ-TRAK stores each point and can save the entire program on the diskette for later recall and editing. The points (0–99) are saved as they are created in a file called TEACH.PGM.

NOTE: When created, the points file is stored on the Solid State disk C:\ as a file called TEMP.TXT and as an editable file called TEACH.PGM. If desired, this file can be renamed and saved on a 3.5" diskette for future re-use, as a program file.

To enter the **TEACH** mode press the **. SAVE PT** key in the BASIC OPERATIONS screen, or press **. SAVE PT** in the **JOG** screen.

<.> SAVE PT. This command selected from either the BASIC OPERATIONS screen, or the **JOG** screen, calls the **TEACH** mode screen:

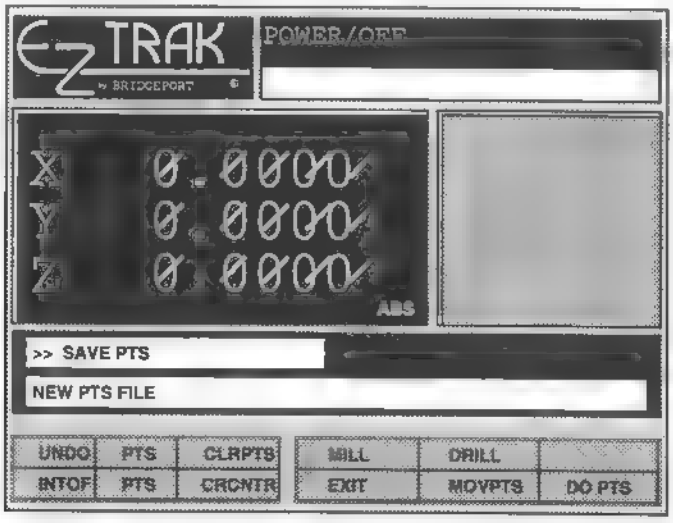


Figure 11-1

The commands available from the TEACH screen are:

1 MILL Press the **1** key to save the current point as a **MILL EVENT**. This means that the EZ-TRAK will mill a straight line to this point from the previous location. Arcs cannot be saved as mill events.

2 DRILL Press the **2** key to save the current position as a **DRILL EVENT**. The EZ-TRAK will make a positioning move to this point when the points are replayed, and then stop and wait so that the hole can be drilled at this location.

+ DO POINTS This key replays the saved points in the same order that they were saved.

. MOVPTS The **.** key allows moving the tool to a point that was previously saved. The system prompts the user to select one point in the points list. After the point is selected, hitting the **.** key and **ENTER** moves the tool to that point.

– CLR POINTS The – key deletes all of the saved points from the points file.

*** UNDO** The * key deletes only the last saved point from the points file. The previous point is then displayed on the screen. The **UNDO** command can be used repeatedly to delete several points.

ESC The **ESC** key exits the **TEACH** mode. When the **TEACH** mode is exited, the programmed points are saved in a file called **TEACH.PGM**.

<left arrow> INTOF This command creates a point at the intersection of two lines that are defined each with two points that are already in the points list. These four points must be consecutive in the list. When this command is selected, the user is prompted for the number of the first of the four points in the list. The user is then shown the coordinates of the new point, and the system prompts for the number where this point is to be stored.

<right arrow> CRCNTR This command finds the center of a circle that is defined with three consecutive points in the points list. This point can then be stored in the points list as a separate point. When this command is selected, the user is prompted for the number of the first of the three points in the points list. The user is then shown the coordinates of the new point, and the system prompts for the number where this point is to be stored.

<up arrow> PTS This command scrolls the points list upward. The top of the points list is the 00 point.

<down arrow> PTS This command scrolls the points list downward. The bottom of the points list is the point 99.

CHAPTER 12
PREVIEW MODE

INTRODUCTION

The **PREVIEW** mode is used to execute and pre-view the cutter path of a part program on the CRT display before actually running the program. The screen shows an XY view of the part and displays tool movements on the screen so that the program can be checked before executing the program.

The **PREVIEW** mode is selected from the **RUN** screen. NOTE: A part program should be loaded into memory (via the **LOAD** command) **before** selecting the **PREVIEW** command.

THE PREVIEW SCREEN

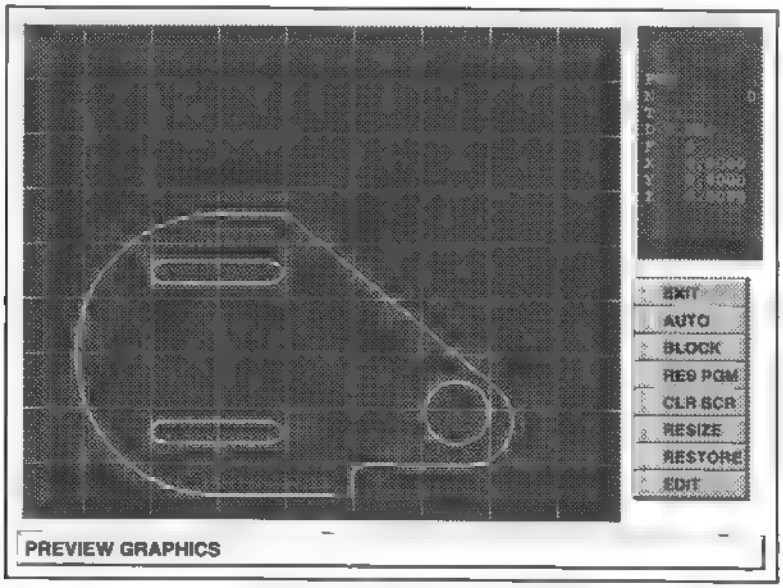


Figure 12-1

KEY FUNCTIONS

0 EXIT The **EXIT** command leaves the **PREVIEW** mode and returns to the RUN screen.

1 AUTO The **AUTO** command sets the loaded program to be run in continuous operation. The preview halts for programmed stops, or tool changes, but does not stop for Z axis adjustment. The program begins when the **AUTO** key is pressed.

2 **BLOCK** The **BLOCK** commands sets the loaded program to be run in single step mode. Each line of a program is executed, and the program is halted until the operator presses the **2 BLOCK** key. The program run begins when the **2 BLOCK** key is pressed.

3 **RES PGM** The **RES PGM** command resets the program back to the beginning. It can then be re-started from the beginning. It is usually a good idea to use the **CLR SCR** command before re-running a program.

4 **CLR SCR** The **CLR SCR** command clears the screen. The **PREVIEW** area is erased so that the program can be seen more clearly. Once the screen is cleared, the erased information cannot be redrawn, except by running the program again.

5 **RESIZE** The **RESIZE** command is used to change the size of the PREVIEW window. When the **RESIZE** command is selected from the PREVIEW screen, the operator is prompted to enter four numbers which control how the PREVIEW screen is displayed. Prompts are displayed for:

Xmin	the left edge of the part
Ymin	the bottom edge of the part
Xmax	the right edge of the part
Ymax	the top edge of the part

The **Xmin** and **Ymin** values can be set to the lower left corner of the part. The **Xmax** and **Ymax** values can be set to the upper right corner of the part.

These values determine the window size of the PREVIEW screen. These numbers are altered slightly to fill the screen area. It is generally a good idea to increase these values so that the part is displayed more towards the center of the screen.

6 **RESTORE** The **RESTORE** command returns the PREVIEW screen to the original size set by the EZ-TRAK, after the screen size has been changed using the **RESIZE** command.

7 **EDIT** The **7 EDIT** key in the PREVIEW mode calls the EDIT mode, and allows the operator to make changes to the program. The program must be saved, if changes are made. If EDIT is invoked from the PREVIEW mode, it willnot automatically return to the PREVIEW mode.

USING PREVIEW

When the **VIEW** command is selected, the program is automatically scanned, and the **VIEW** window is sized accordingly. The screen displays:

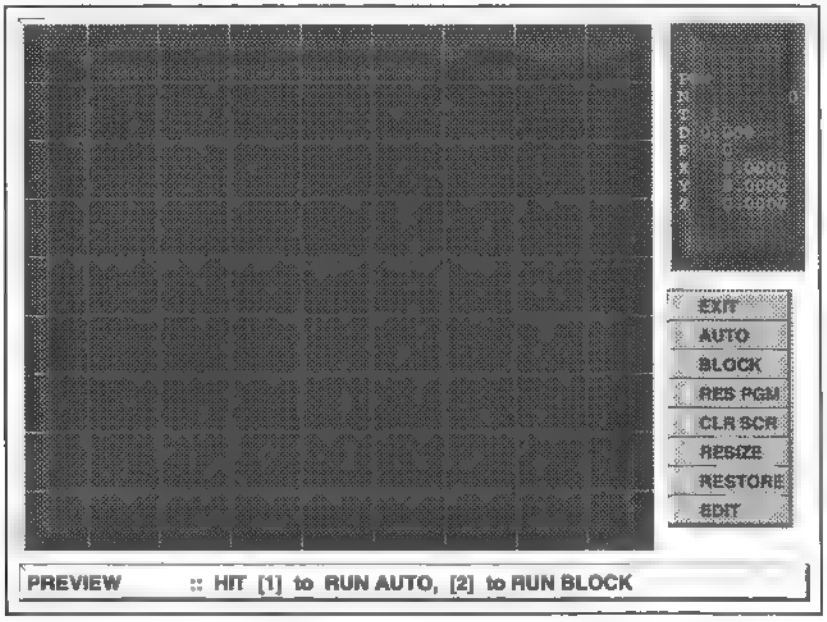


Figure 12-2

Press the **1 AUTO** key to begin simulation of the part program on the screen. The **START** button must also be pressed after drilling holes, or programmed stop events and tools changes, just as if the program were actually executing on the machine.

Milling moves are shown on the screen as solid lines. Rapid moves are shown as dotted lines. Drilling locations are shown as circles with a + symbol at the center.

To zoom in on a particular part of a program, use the **RESIZE** command to change the window settings. Use the **RESTORE** command to return the window to its original settings.

At the beginning of a program, the operator is prompted:

|| HIT [1] to RUN AUTO, [2] to RUN BLOCK

When a tool change is executed the operator is prompted:

|| HIT [+] to CONTINUE, or [0] to STOP

At the end of a program the operator is prompted:

|| HIT [3] to RESET PROGRAM

Appendix A
EZ-TRAK System Overview

Introduction

This section includes:

- A description of the EZ-TRAK SX and DX computer hardware
- A description of the EZ-TRAK SX and DX System Software
- A description of how the EZ-TRAK SX and DX handle USER DATA

The EZ-TRAK SX and DX Control Hardware

The EZ-TRAK SX control contains two micro-processor based systems. The first is an 80386 based PC AT micro-computer which runs the operator interface displayed on the computer screen. The second micro-processor based system is a 32-bit 68030 based Bridgeport-designed Motor Drive Controller (BMDC) which runs the real time system tasks. The EZ-TRAK DX has an 80386 DX based PC AT micro-computer which runs the operator interface displayed on the computer screen.

Unlike competitive PC based CNC systems, which are loosely coupled via serial or parallel links, the EZ-TRAK is a true PCNC system– the BMDC board is plugged directly into the PC data bus, and the two systems communicate via shared memory. When combined with the on-board 96 bit floating-point processor, the SX and DX controls leave older 16 bit based CNC systems way behind in terms of computing power.

Standard throughput in the EZ-TRAK SX is 250 data blocks per second. 256 kilo-bytes of high speed memory (equal to more than 2000 ft. of paper tape) is provided on the BMDC board for part program storage. In addition to the 1 mega-byte of RAM used by DOS and Bridgeport Operating System on the PC AT, an additional 1 mega-byte RAM disk is provided for fast data access.

The EZ-TRAK DX has similar throughput to the SX but includes a 170Mb hard drive rather than the RAM disk. This allows for greater storage capability than on the SX.

A 9" monochrome VGA monitor, pop-up windows, and soft keys make control operation quick and easy. All machine functions are selected via the keypad which is linked to on-screen operator commands.

EZ-TRAK SOFTWARE

The software which drives the EZ-TRAK is best described in terms on the hardware that runs it. All of this software is loaded from the System Disk at startup.

PC AT. The software used on the PC AT consists primarily of the Microsoft DOS v. 6.0 operating system, and EZTRAK.EXE, the operator interface software.

> **DOS** (disk operating system). DOS is a collection of routines that perform basic computer tasks such as starting the computer (booting up), moving data to and from disks and peripheral devices, and managing and allocating memory space.
> On the EZ-TRAK control, DOS is the bottom layer of the software that runs on the PC AT. In normal operation, DOS is not visible to the user. On start-up, a routine called AUTOEXEC.BAT automatically loads the EZ-TRAK software into the system and starts it up. For more information on DOS, refer to the MS-DOS User's Reference Manual.
>
> **EZTRAK.EXE**. This software contains the routines that the operator uses to run the EZ-TRAK. These routines call up the display screens, execute the commands the operator selects and communicate with the BMDC board to update system status.

BMDC Motor Drive Controller.

> **BMDC.BIN**. These routines provide real time control of the system and include the part program parser and executor, 2 axes of servo drive control, interpolation algorithms, and system monitor.

SYSTEM DISK. The SYSTEM DISK is a 3.5" high-density floppy disk that stores all of the software for the EZ-TRAK SX and DX, as well as any part programs that the user may have created and stored. This disk is essential to running the EZ-TRAK SX. If the SYSTEM DISK is lost, or damaged, and no backup is available, the system is useless until a replacement disk is available. The EZ-TRAK DX has a hard drive that may be used for part program storage rather than using the SYSTEM DISK.

It is highly recommended that you keep several copies of the SYSTEM DISK in a safe place.

> **NOTE:** Certain parameter files are updated to the SYSTEM DISK. This includes axes backlash values and the SET machine coordinate offset values. Also, when part programs are SAVED, they are stored on the System Disk. Do **not** write-protect the SYSTEM DISK, otherwise these updates cannot occur.

The following files are on the EZ-TRAK SX and DX SYSTEM DISK:

DOS	DIR	contains directory of DOS system routines
AUTOEXEC	BAT	Start-up routines
COMMAND	COM	DOS commands
CONFIG	SYS	PC AT configuration

HLV050B	FN_	font file
HLV025B	FN_	font file
BLD013	FN_	font file
BLD019M	FN_	font file
BLD019B	FN_	font file
BMDC	BI_	BMDC software
EZLOAD	EXE	Loads the BMDC.BIN driver to the BMDC card
EZTRAK	EX_	PC AT operator applications package
EZUTILS	EXE	Disk and communications utilities
EXPAND	EXE	File decompression utility
SYS	BEZ	system parameters
1	BAT	EZ-TRAK SX preparation file
0	PGM	EZ-TRAK SX part program

NOTE: Many of the files on the EZ-TRAK SX SYSTEM DISK are compressed in order to allow as much space as possible for part programs. The font files, the BMDC driver, and the EZTRAK program are automatically decompressed when the system requires these files. It is **not** necessary, or recommended, for the user to attempt to decompress these files.

USER DATA

The SYSTEM disk also contains USER created part programs. Two types of files can be used on the EZ-TRAK SX. Files with the extension **.PGM** are created on EZ-TRAK machines. Files with the extension **.TXT** are compatible with other Bridgeport controls. Both of these types of programs may be found on the EZ-TRAK SX and DX SYSTEM DISKS. The space available for part programs on the SYSTEM DISK is over 300K. The SYSTEM disk is automatically read into the RAM disk of the EZ-TRAK SX at the machine start-up to improve the operating speed.

USER DATA PATHS

There are three storage areas for data in the EZ-TRAK SX. Understanding how the system handles data is necessary to properly operate the EZ-TRAK SX.

1. The SYSTEM disk containing the operating system software and part programs is inserted into the floppy disk drive mounted in the control cabinet. The designation of the floppy drive is **A:**.

2. The system contains a solid state RAM disk so that the control has fast data access. Programs and system software are autoamtically loaded ***from*** the SYSTEM disk to the RAM disk on START-UP. Programs are automatically saved ***to*** the RAM disk and the SYSTEM disk when they are SAVED by the operator. The designation of the RAM disk is **C:**.

If it is necessary to load a part program from the floppy disk (**A:**) to the RAM disk (**C:**) after start-up, then the **UTILS** command is used.

3. Before a part program can be executed, it must be loaded into the BMDC memory. The **LOAD** command transfers a part program to this area of memory. The **SAVE | RUN** command in the MDI mode will also automatically load the edited program into the BMDC memory area.

Appendix B
Axes and Coordinates

Some Background Information

When we talk about a machine tool cutting a part, we say that the cutter moves in three axes. These are the three directions in which the tool moves in order to cut the material of the part. These directions are left and right (the X axis), forward and backward (the Y axis), and up and down (the Z axis). If you watch the machine tool in motion though, it is the worktable, and the part itself that move (forward and backward, and left and right) not the cutting tool, or cutter.

It is easier to think of the tool moving, so that the motion makes more sense. This way the tool does all of the movement. It also makes sense when you think about the directions and the values they represent on the screen. When the X coordinate is increasing in value, the motion of the tool is to the operator's right. When the Y coordinate is increasing in value, the tool is moving towards the back of the machine.

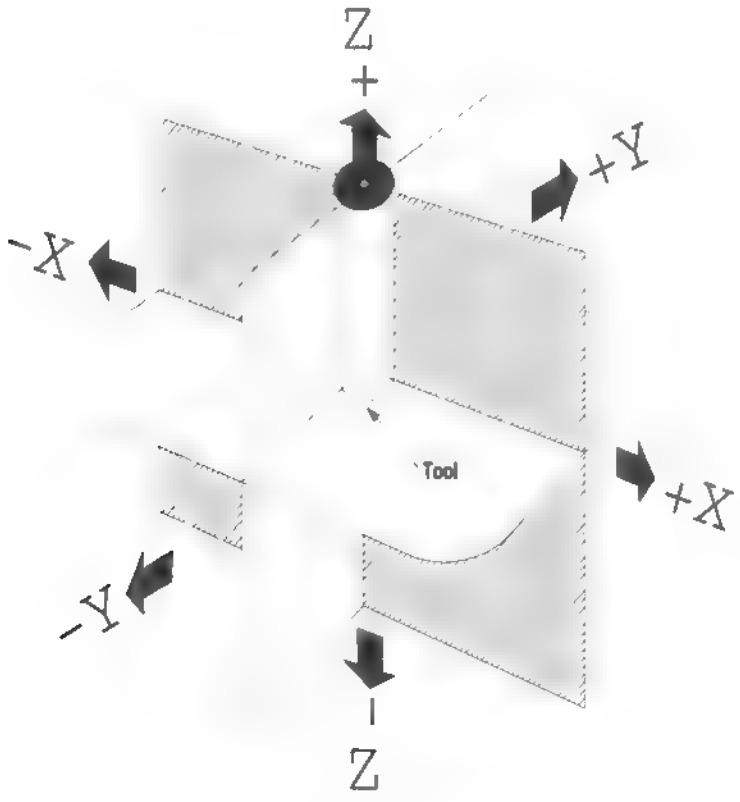


Figure B-1

Axes and Coordinates

We've already mentioned the terms **axis**, and **coordinate**, but what do they have to do with the EZ-TRAK?

The EZ-TRAK (and all CNC machine tools) use a **coordinate system** to identify where the tool is at any one moment, and to define where the tool is moving to when it is cutting chips. This coordinate system is called a **Rectangular Coordinate System**.

A Rectangular Coordinate System is based on a grid of lines which have set distances from one central point called the **origin**. Every point on the grid is given both an X and a Y coordinate which show how far to move to get to that point from the origin. Coordinates are usually shown in parentheses **( )** with a comma separating them. They are always given in the same order, X first, and then Y. A Z coordinate is added when the point can move along a third axis, called the Z axis. The Z coordinate on the EZ-TRAK SX determines how deep the tool is cutting into the part. The Z coordinate is always listed last when the coordinates are shown in parentheses.

The origin is given the coordinates (0,0) to make things simple. This means that to move to a point we'll call **A** that has the coordinates (3,2), you would start at the origin and move 3 grid lines (usually inches) along the X axis, and then 2 grid lines along the Y axis. Or you could move 2 inches along the Y axis and then 3 inches along the X axis. You still end up at point **A**, but the path you took to get there is different.

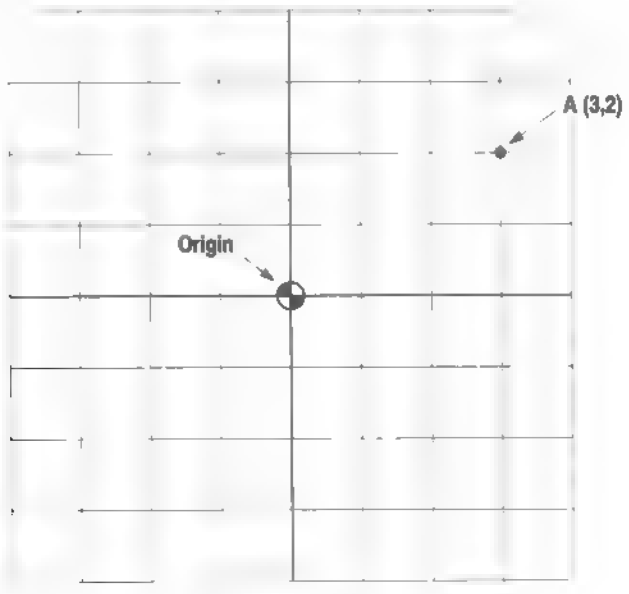


Figure B-2

When you move from one point to another on the grid, you count up or down depending on the direction you're moving to get to the desired point. If you move to the right, you count up, or add to the X coordinate. If you move left, you count down, or subtract one for each grid line you cross as you move to get to the target point. If you move towards the top of the grid you add to the Y coordinate, and if you move towards the bottom of the grid, you subtract one for each line that you cross.

If you cross to the left side of the origin, or below the origin, you reach zero and then go beyond it. These are negative numbers and are shown with a minus sign, like -1. The minus in -1 shows that you are one line to the left or below the origin, depending on whether the -1 is the X coordinate or the Y coordinate.

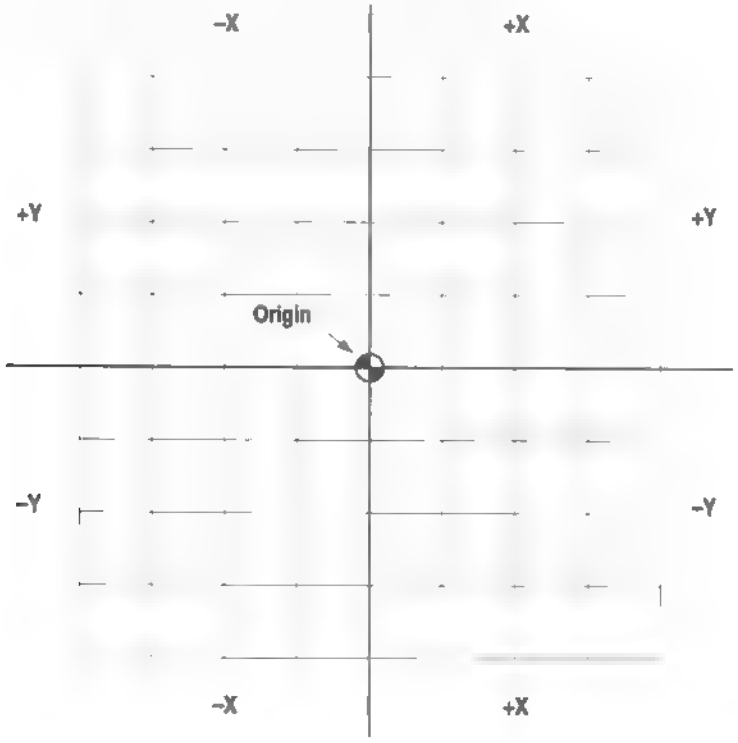


Figure B-3

As you move on the grid the number of lines that you cross in each direction is the distance that you moved along each axis to get to the new point. This gives two distances for each move, one along the X axis, and one along the Y axis. It is easy to calculate the distances necessary to move from one point to another.

Start with the X coordinate of each point. Take the higher number of the two X coordinates and subtract the lower number. Remember that subtracting a negative number is the same as adding a positive number (e.g. 3 – -2 = 5). The answer is the distance between the X coordinates of the two numbers. Repeat this for the Y coordinates.

For example, if we take two points (7,-2) and (3, 5) (shown in Figure B-4). Take the higher of the two X coordinates and subtract the lower number (7 – 3 = 4). Repeat for the Y coordinates (5 – -2 = 7). The distances are 4 in the X and 7 in the Y.

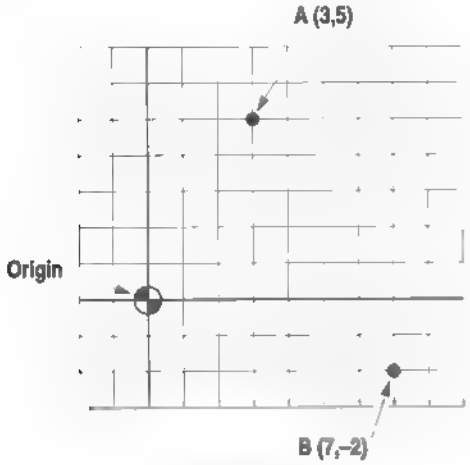


Figure B-4

This doesn't tell you how to move to get to the new point though. If you were at the point (7,-2) and wanted to move to the point (3,5) you would need to know more than just how far to move. You need to know **what direction** to move.

Compare the X coordinates again. You are starting at a point whose X coordinate is 7, and you want to go to a point whose X coordinate is 3. 7 is greater than 3 so the movement direction is towards the lower numbers on the left. This gives the direction along the X axis. The same method is used to find the Y direction. You are starting at a point whose Y coordinate is -2. You are moving to a point whose Y coordinate is 5. Since -2 is less than 5, the movement direction is towards the greater numbers at the top of the grid. This gives the direction along the Y axis.

Absolute vs. Incremental Programming

There are two ways to program a machine tool to move from one point to another. You can instruct the machine to move from the current location to the point whose coordinates are (X_1,Y_1). This is called **absolute** programming because the coordinates you give the machine are based on a known origin (0,0) location.

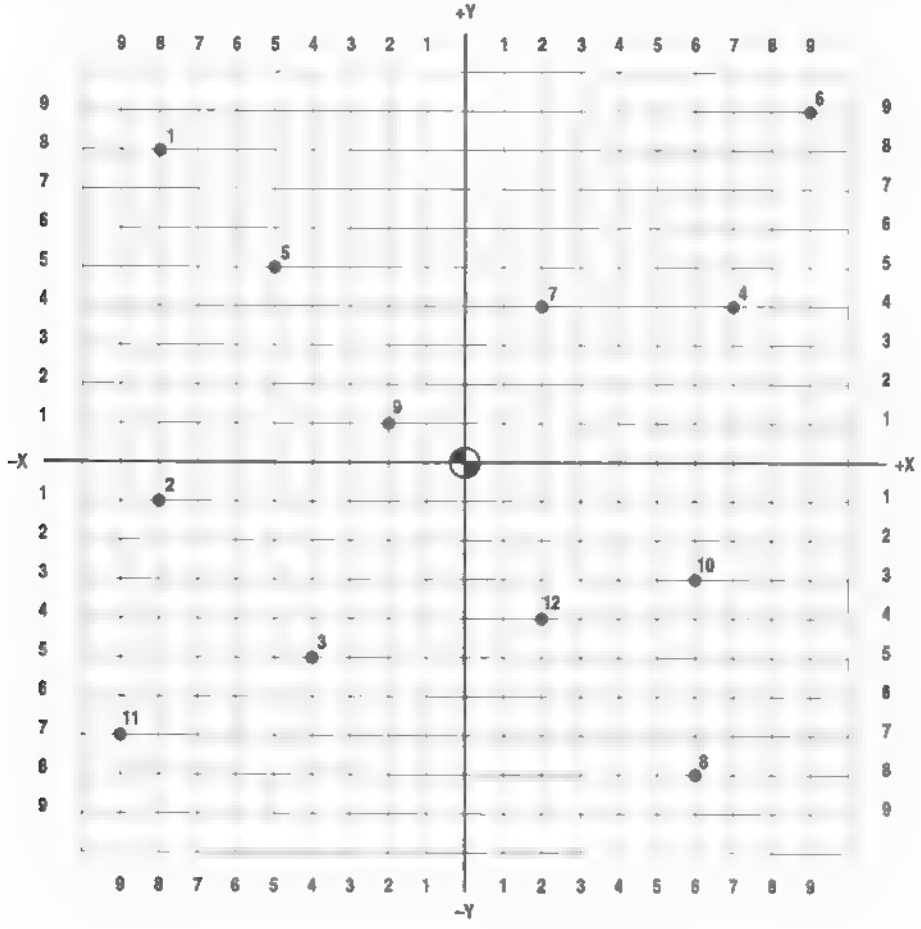
The second way to program this same move, is to tell the machine tool how far to move in each axis. This means that the point is given as two distances from the current location, one along the X-axis, the other along the Y-axis. Each distance is accepted as a direction and distance. For instance, giving **-2** as the X distance moves the tool to the left where giving **2** would move the tool to the right. Each of these would move the tool the same distance from the current location, but in opposite directions. This is called **incremental** programming, and it does not matter where the origin is located.

In programming the EZ-TRAK, you may use either **absolute** or **incremental** programming. Sometimes it is easier to use one or the other. The program mode is shown in the programmed instructions for the EZ-TRAK as **ABS** or **INC**. This is usually the third item seen in the instruction line. For example:

```
0000 LINE INC X4.000 Y0.000 Z0.000 F10.
```

This instruction tells the EZ-TRAK to mill a line from the current position, four inches in the positive X direction, zero inches in the Y direction, and with the Z set at zero, at a feed rate of 10 inches per minute.

Below is a grid with some points marked on it. The origin is at the center of the grid. Starting at the first point given, move to the next point, and write down the absolute and incremental values of the move. Remember when you move to the right or towards the top of the grid, your movement is positive, when you move left or down, it is negative.



ABSOLUTE

example:

7 to 11 *X -9* *Y -7*

6 to 1	X_____	Y_____
5 to 4	X_____	Y_____
8 to 3	X_____	Y_____
2 to 4	X_____	Y_____
4 to 5	X_____	Y_____
5 to 6	X_____	Y_____
12 to 7	X_____	Y_____
10 to 8	X_____	Y_____
4 to 9	X_____	Y_____

INCREMENTAL

7 to 11 *X -11* *Y -11*

6 to 1	X_____	Y_____
5 to 4	X_____	Y_____
8 to 3	X_____	Y_____
2 to 4	X_____	Y_____
4 to 5	X_____	Y_____
5 to 6	X_____	Y_____
12 to 7	X_____	Y_____
10 to 8	X_____	Y_____
4 to 9	X_____	Y_____

ANSWERS TO EXERCISES

ABSOLUTE

example:

7 to 11 *X -9* *Y -7*

6 to 1	X –8	Y 8
5 to 4	X 7	Y 4
8 to 3	X –4	Y –5
2 to 4	X 7	Y 4
4 to 5	X -5	Y 5
5 to 6	X 9	Y 9
12 to 7	X 2	Y 4
10 to 8	X 6	Y –8
4 to 9	X –2	Y 1

INCREMENTAL

7 to 11 *X -11* *Y -11*

6 to 1	X –17	Y -1
5 to 4	X 12	Y -1
8 to 3	X –10	Y 3
2 to 4	X 15	Y 5
4 to 5	X –12	Y 1
5 to 6	X 14	Y 4
12 to 7	X 0	Y 8
10 to 8	X 0	Y –5
4 to 9	X –9	Y –3

Appendix C
EZ-TRAK Programming Example

As an example, the following part is given with the programmed instructions. The blueprint for the part is shown below.

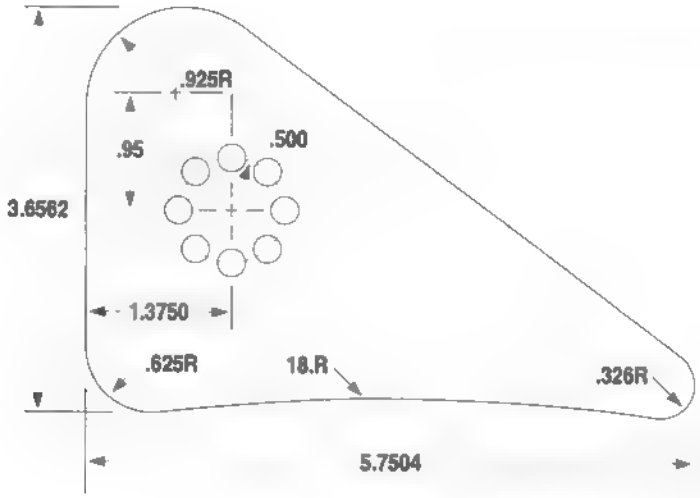


Figure C-1

To facilitate programming, the part is positioned as shown below. The part origin was chosen for convenience. The numbers shown below could also be calculated using the GEOMETRY HELP commands.

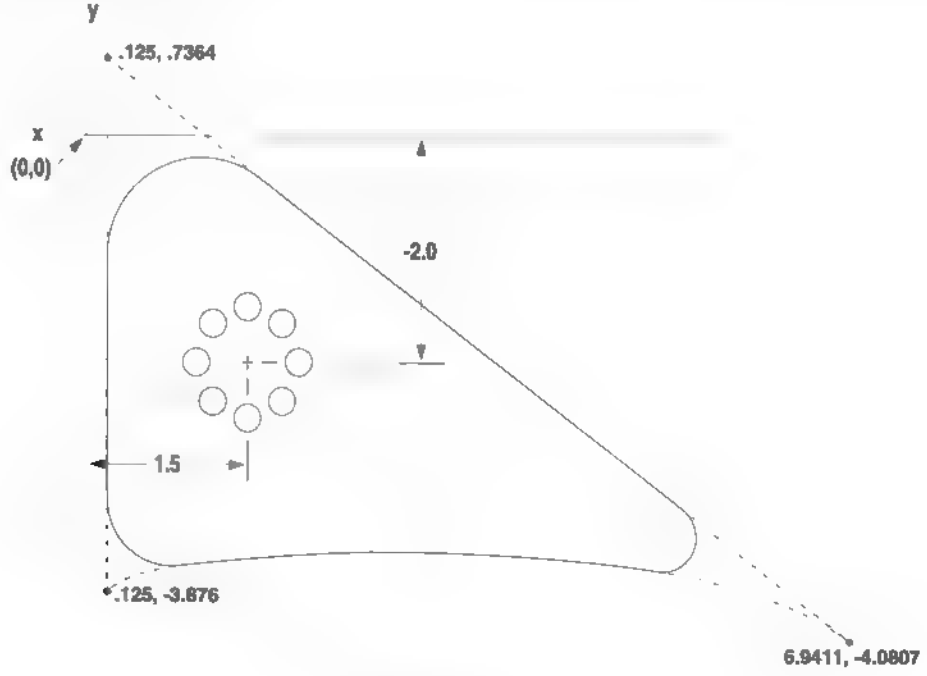


Figure C-2

```
0010 ||TOOLCHG T1
```

The first line of the program should be a tool change, so that the operator has an opportunity to load the correct tool, for the start of the program. This is essential if the program will be repeated and it requires more than one tool.

```
0020 COMP|ON LFT D.25 X.125 Y-2. Z.1 Z-.2 P0 F20
```

The starting point is in the middle of the left side line. The part will be milled CW (tool left) using a cutter diameter of .25. The cutter will move to the start point at a clearance Z value (Z.1) at a rate of 100 ipm. The operator will be prompted to move the tool to mill depth.

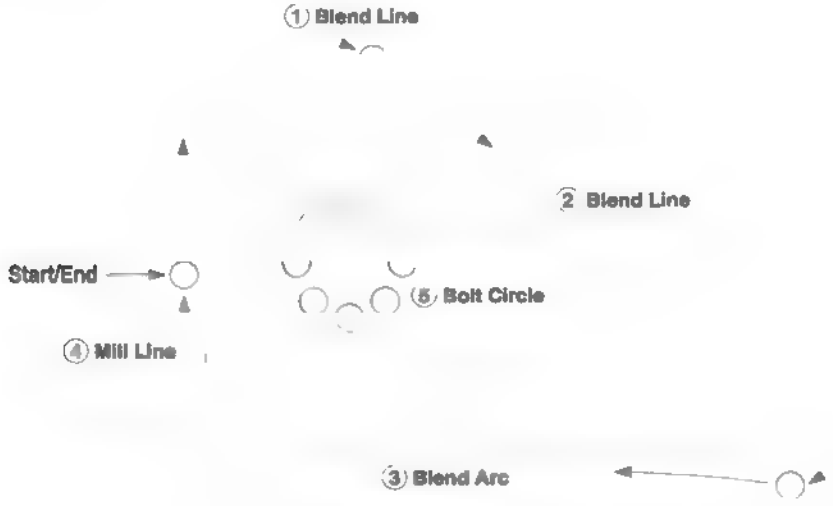


Figure C-3

① `0030 BLEND|LN ABS X.125 Y.7364 Z-.2 R.925 CW F20`

This line mills the line and the blend arc connecting the next line.

② `0040 BLEND|LN ABS X6.9411 Y-4.0807 Z-.2 R.326 CW F20`

This block mills the ② line and the blend arc connecting the next arc.

③ `0050 BLEND|ARC|RADIUS ABS CCW X.125 Y-3.875 Z-.2 R18.R.625 CW F20`

This line mills arc ③ and the blend arc connecting the next line.
NOTE: The arc is defined by a radius and an endpoint.

④ **0060 LINE ABS X.125 Y-2.000 Z-.2 F20**

This line mills the last line of the part shape.

0070 COMP|OFF Z.1

At the end of milling the shape the operator will be prompted to lift the tool (Z.1).

0080 ||TOOLCHG T2

This line prompts the operator to make a change to tool number 2, a drill.

⑤ **0090 DR/BC R.5 XC1.5 YC-2. Z-.2 A0. P8.**

This block calls a canned cycle to drill an 8 hole bolt circle pattern with a radius of .5, a center of XC1.5 YC -2. and the first hole along the X axis.

0100 ||ENDPRGM

This line resets the part program to the top of the text.

Appendix D
Using the Calculator

CALC

In many of the commands throughout the EZ-TRAK software, coordinates are required as entered data. Often it is necessary to calculate the correct coordinates using other numbers, or trigonometric functions. These calculations can be carried out by using the **CALC** mode in the EZ-TRAK software. This mode is called by pressing the * key on the keyboard whenever coordinates are required.

The screen displays a calculator-like keypad at the bottom of the screen when the **CALC** mode is called. From this screen, complex algebraic equations, and trigonometric functions can be entered and evaluated. When the equation has been entered, press **Enter** to evaluate the equation. The results are shown on the screen in the **CALC** window. Press **Enter** again to place the results in the active coordinate field.

Figure D-1

At the top of the **CALC** window is the word **CALC:**. This shows the equation entered. At the right of the window is the numeric keypad, used for entering numbers and simple mathematical functions like addition, subtraction, division and multiplication using the **+**, **–**, **/**, and ***** keys.

On the lower left side of the **CALC** window the arrow cursor keys are shown. These are used to enter specific characters. The **<left arrow>** cursor key places an open or left parenthesis into the equation field. Each left parenthesis **(** must be matched by a right parenthesis **)** entered by pressing the **<right arrow>** cursor key.

Complex Functions

When one of the function keys is selected, the screen displays a secondary input field. **[ENTER] FUNC:**

Simple arithmetic functions (+,–,*,/) can be input along with the complex functions listed below.

Some of the complex functions (**ATAN**, and **DIST**) require two numbers to be entered.

F1 SIN This command enters the trigonometric **SIN(** function into the equation field. The operand for this function is a number, positive or negative which represents an angle in a right triangle. The angle is defined in degrees (e.g 37.5).

F2 COS This command enters the trigonometric **COS(** function into the equation field. The operand for this function is a number, positive or negative which represents an angle in a right triangle. The angle is defined in degrees (e.g. 37.5).

F3 TAN This command enters the trigonometric **TAN(** function into the equation field. The operand for this function is a number, positive or negative which represents an angle in a right triangle. **Note**. Do not enter **90.** degrees for this function. The TAN of 90 degrees is not defined.

F4 ASIN This command enters the **ASIN(** function into the equation field. This function returns the arcsin of the entered number. The number entered for this function must be between **-1.0000** and **1.0000**, otherwise an error is returned by the system , and zero is entered for the coordinate field.

F5 DIST This command enters the **DIST(** function into the equation field. This function requires two numbers. Type the first number, then press **Enter**. Type the second number then press **Enter** again. This function uses the Pythagorean Theorem (A^2 + B^2 = C^2) to calculate the length of the third side of a right triangle. The entered numbers are the lengths of the first two sides of the right triangle. The calculated value is the square root of the sum of the squares of the two entered numbers. For example if the entered equation is **DIST(3,4)** then the calculated value is **5.0000**.

F6 ATAN This command enters the trigonometric **ATAN(** function into the equation field. This function requires two numbers separated by a comma, and surrounded by parentheses. The **ATAN** function calculates one angle in a right triangle given the length of the opposite side, and the adjacent side. The first operand should be the length of the side opposite the angle. For example if the entered equation is **ATAN(3,4)** then the calculated value is **36.8966** the measure of the angle opposite the side of length **3**.

<down arrow> SQRT This command enters the **SQRT(** function into the equation field. This function finds the square root of the entered value. If a negative number is entered, the system returns an error and the equation value is set to zero. The number entered in the coordinate field is zero.

<up arrow> EXP This function is used to enter an exponent. The exponent must be a whole number and must not be negative. The system returns the value of the operand if the exponent is either nagative or contains a decimal. Fractions also may not be used to express an exponent.

Trigonometric Functions

The six trigonometric functions are derived using a circle with a radius of 1, and a right triangle which lies inside the circle. The relationships of the sides and angles can be calculated using various formulae, as shown in the table and illustration below.

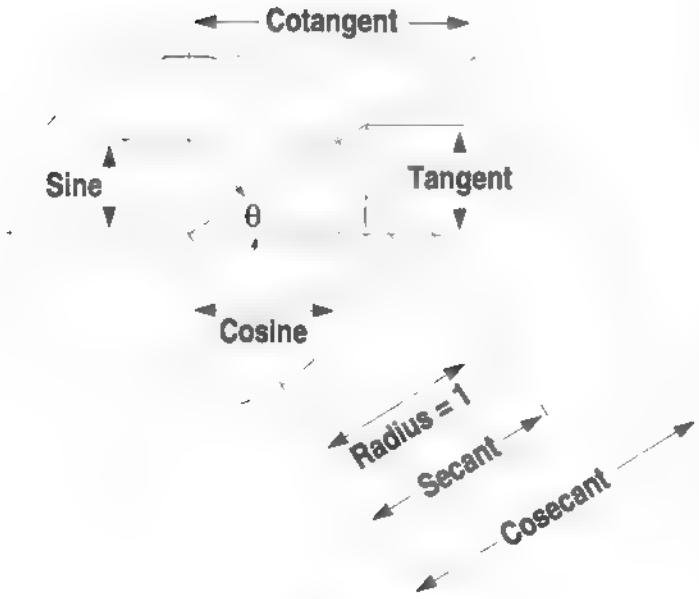


Figure D-2

FORMULAS FOR FINDING FUNCTIONS OF ANGLES	
Side opposite / Hypotenuse	= SINE
Side adjacent / Hypotenuse	= COSINE
Side opposite / Side adjacent	= TANGENT
Side adjacent / Side opposite	= COTANGENT
Hypotenuse / Side adjacent	= SECANT
Hypotenuse / Side opposite	= COSECANT

FORMULAS FOR FINDING THE LENGTH OF SIDES FOR RIGHT-ANGLE TRIANGLES WHEN AN ANGLE AND SIDE ARE KNOWN	
Length of side opposite	Hypotenuse x Sine Hypotenuse ÷ Cosecant Side adjacent x Tangent Side adjacent ÷ Cotangent
Length of side adjacent	Hypotenuse x Cosine Hypotenuse ÷ Secant Side opposite x Cotangent Side opposite ÷ Tangent
Length of Hypotenuse	Side opposite x Cosecant Side opposite ÷ Sine Side adjacent x Secant Side adjacent ÷ Cosine

Figure D-3

Appendix E
GEOMETRY HELP

Introduction

This section of this manual discusses the use of the **GEOMETRY HELP** functions that are available in many of the DO EVENT and MDI commands in the EZ-TRAK software. Each of the commands in the GEOMETRY HELP menu is discussed in this section, and is detailed with several illustrations.

Calling up the GEOMETRY HELP screen

The **GEOMETRY HELP** screen is called up when the **/GEO** button (the / key) is pressed while entering data into one of the DO EVENT or MDI commands. When the GEOMETRY HELP screen is called, the screen displays the menus shown in Figure E-1.

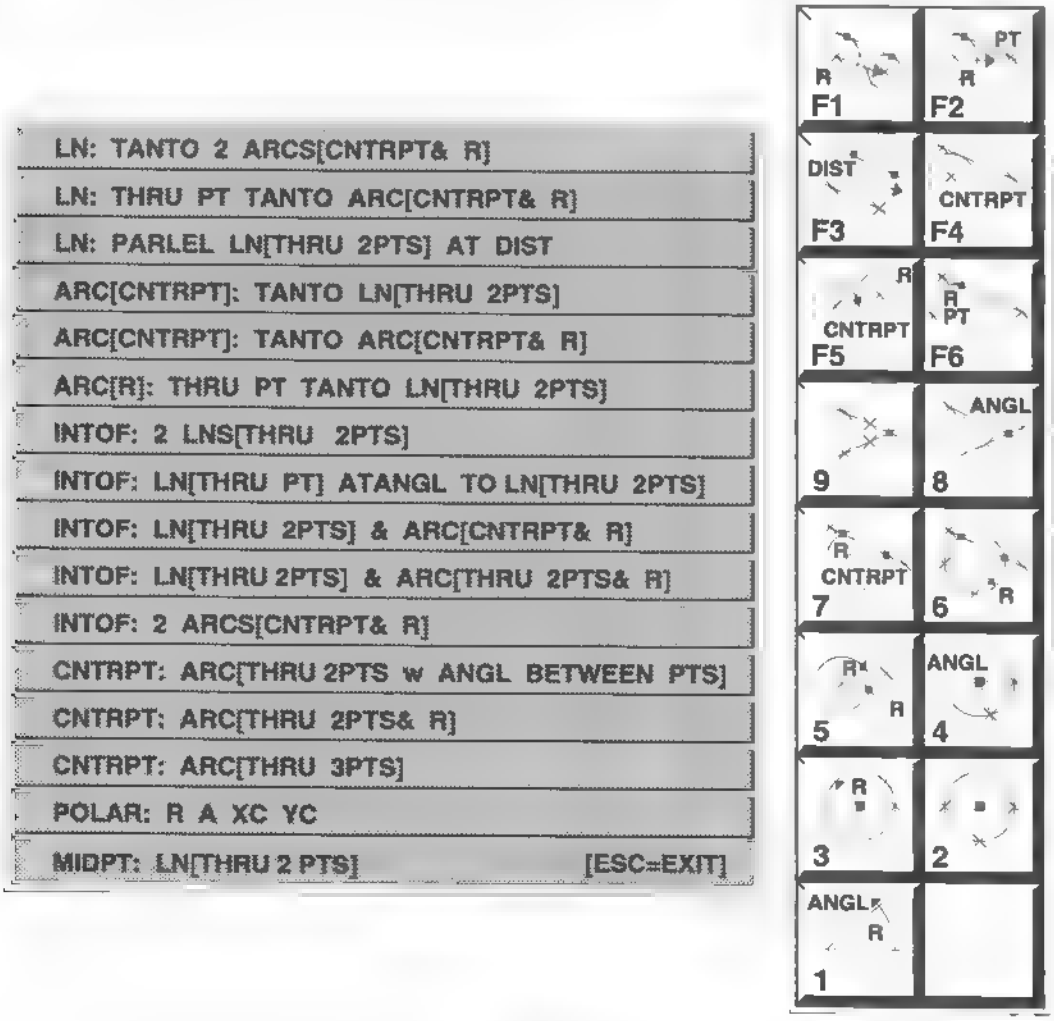


Figure E-1

The left side of this menu lists each of the GEOMETRY HELP commands, and the appropriate key which calls each one. The right side of the menu gives a graphic image of each command and the data it can calculate. The appropriate key is also listed with each of these graphic images.

USING GEOMETRY HELP

Drawings from which parts are machined are not always dimensioned with all the data necessary to make a part program. To help with this situation, the EZ-TRAK has a GEOMETRY HELP function which automatically calculates the coordinates of the geometry most frequently used in part drawings. This mode is called by pressing the / key whenever coordinate data is requested.

The needed function is selected by pressing one of the keys that corresponds to a function on the screen. The function data box is then shown on the screen, and the required data must be entered.

GEOMETRY HELP COMMANDS

There are fifteen different GEOMETRY HELP commands. Each command is listed in this section with illustrations and examples, in the order they appear in the menu.

F1: LN: TANTO 2 ARCS [CNTRPT & R]

This command calculates the intersection points of a line which is tangent to two arcs, specified by their center points and radius values.

Note: There are four different lines that can be described as tangent to any two arcs. An example of this is shown in Figure E-2.

Figure E-2

The two lines which intersect between the two arcs are described as one set of lines (Figure E-3), and the two lines which do not intersect between the arcs are described as a different set of lines (Figure E-4).

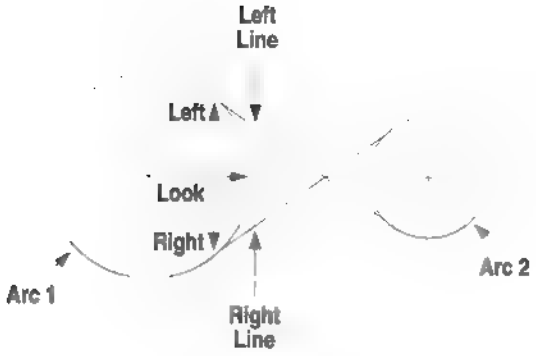


Figure E-3

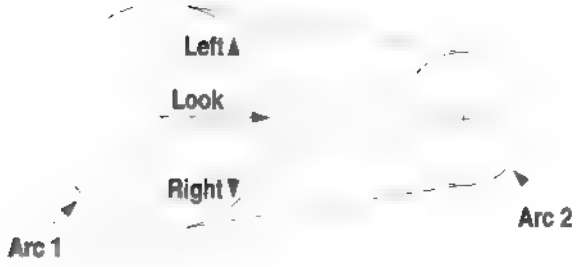


Figure E-4

Each set of two lines, (intersecting and non-intersecting) has a line on the left and a line on the right. These are determined by looking from the center of the first arc to the center of the second arc. See Figures E-3 and E-4.

Figure E-5

ARC [1]: XCntr — The X coordinate of the center point of arc 1.

YCntr — The Y coordinate of the center point of arc 1.

Radius — The radius value of arc 1.

ARC [2]: XCntr — The X coordinate of the center point of arc 2.

YCntr — The Y coordinate of the center point of arc 2.

Radius — The radius value of arc 2.

Select XSECTNS — This selects the set of inter secting lines or non-intersecting lines. See Figures E-3 and E-4.

Select DIR — This selects the line on the left or right. [1=left 2=right]

Figure E-6

When all of the data is entered, the system calculates the two intersection points for the chosen line. The coordinates of the two points are displayed as shown in Figure E-7. One of these points can be chosen as a location in a program, or a DO EVENT command. To select one of the two points, enter the number of the desired point, (either **1** or **2**) in the box shown below the points in Figure E-7. The chosen point coordinates are entered automatically into the correct data fields of the command previously selected, when the **Enter** key is pressed.

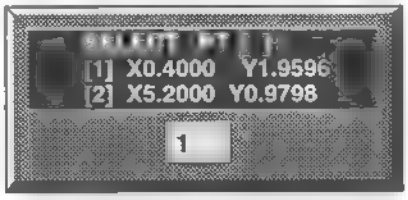


Figure E-7. The Calculated Intersection Points (See Figure E-6)

F2: LN: THRU PT TANTO ARC [CNTRPT & R]

This command calculates the intersection point of an arc and a line that is tangent to the arc. The line is defined by identifying the endpoint of the line which is not on the arc (shown by an X in Figure E-8). The arc is defined by its centerpoint, and radius. Figure E-8 shows how the line and arc are defined.

Figure E-8

Note: There are two different lines that can be defined through a point and tangent to an arc.

The two lines fall on either side of the arc. These lines are specified as being on the left and right of the arc. The direction is determined by looking from the center of the arc towards the specified point, as shown in Figure E-9.

The correct line is chosen by entering the direction in the **Select DIR** parameter. Enter a **1** for the direction if the line is on the **left**, or enter a **2** if the line is on the **right**.

In the example shown in the **F2** window (figure E-10) the direction of the line is **right** (See figure E-11). The **Select DIR** parameter has a value of **2** because the line is on the right.

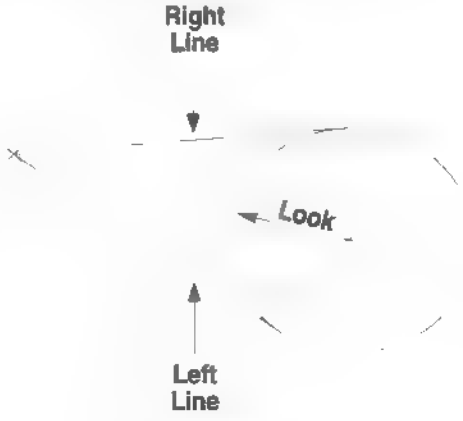


Figure E-9

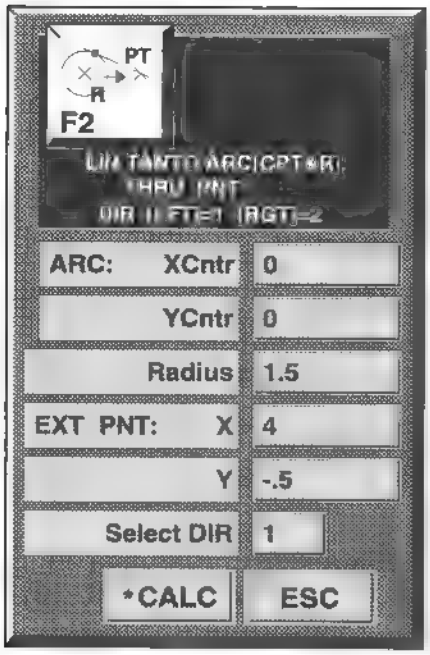


Figure E-10

Figure E-11

ARC :	**XCntr**	This is the X coordinate of the center point of the arc.
	YCntr	This is the Y coordinate of the center point of the arc.
	Radius	This is the radius value of arc 1.
EXT PNT:	**X**	This is the X coordinate of the external point.
	Y	This is the Y coordinate of the external point.
Select DIR		This selects the line on the left or right. The direction is set by looking from the center of the arc towards the external point Enter **1** to select the line on the **left**, enter **2** to choose the line on the **right**.

When all of the data is entered, and **Enter** is pressed, the system calculates the intersection point for the chosen line. The point is entered automatically into the correct data fields of the command.

F3: LN PARLEL LN [THRU 2 PTS] AT DIST

This command calculates two points which are a given distance from a line. The line is defined by two points. The two calculated points form a line which is parallel to the given line. Figure E-12 shows the given points with an X, and the calculated points as •.

Figure E-12

The new line must be selected by giving a direction either left or right, from the given line. The direction is determined by looking from the first point of the given line to the second point of the given line. This is shown in Figure E-14 by the arrow at point 1.

Note: There are two lines that can be a specific distance from a given line, and be parallel to it.

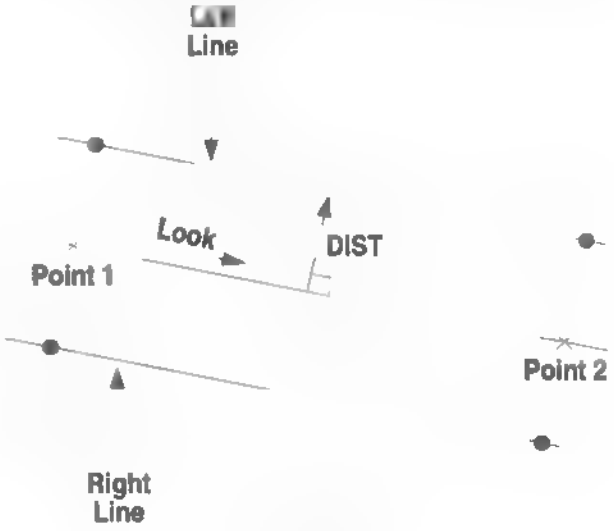


Figure E-13

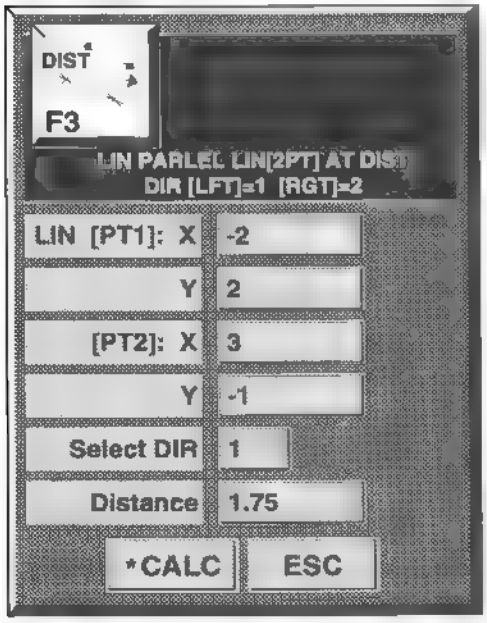


Figure E-14

Figure E-15

Note: In the example in Figure E-15, the direction is **left**. The first point entered (shown in Figure E-14) is (-2,2).

LIN	**[PT1]:**	**X**	This is the X coordinate of the first point of the line.
		Y	This is the Y coordinate of the first point of the line
	[PT2]:	**X**	This is the X coordinate of the second point of the line.
		Y	This is the Y coordinate of the second point of the line.
Select DIR			This selects the line on the left or right. The direction is set by looking from the first point of the line towards the second point Enter **1** to select the line on the **left**, enter **2** to choose the line on the **right**.
Distance			This sets the distance away from the given line that the new line is placed.

When all of the data is entered, the system calculates the two points for the new line. The coordinates of the two points are displayed as shown in Figure E-16. One of these points can be chosen as a location in a program, or a DO EVENT command. To select one of the two points, enter the number of the desired point, (either **1** or **2**) in the box shown below the points in Figure E-17. The chosen point coordinates are entered automatically into the correct data fields of the command previously selected, when the **Enter** key is pressed.

Figure E-16

F4: ARC [CNTRPT] : TANTO LN [THRU 2 PTS]

This command finds the intersection point of an arc and a tangent line The centerpoint of the arc, and two points on the line must entered. Figures E-17 and E-18 show examples of how the line and the arc might be placed.

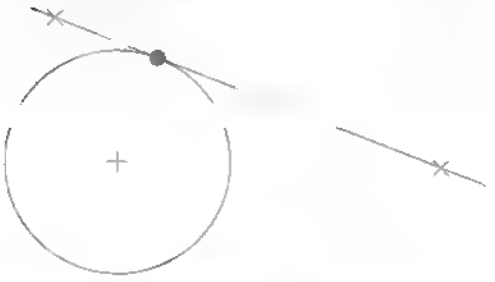


Figure E-17

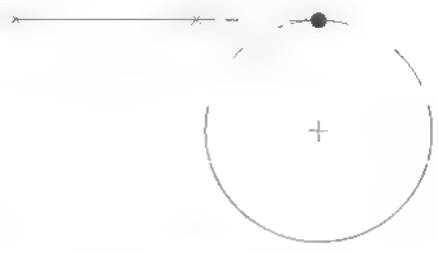


Figure E-18

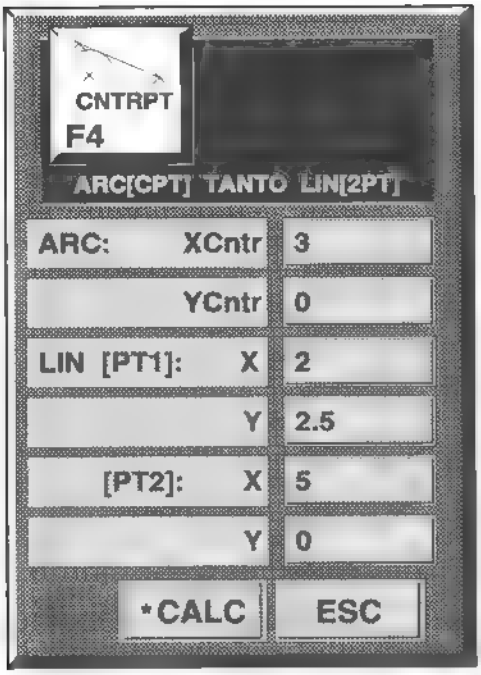


Figure E-19

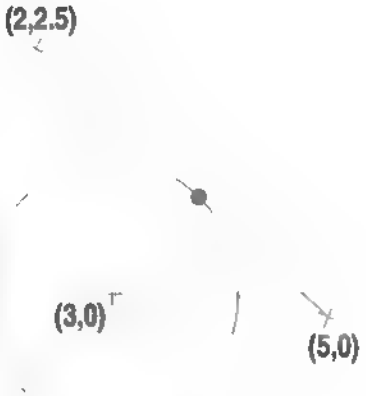


Figure E-20

ARC: **XCntr** This is the X coordinate of the arc's centerpoint.
YCntr This is the Y coordinate of the arc's centerpoint.

LIN [PT1]: **X** This is the X coordinate of the first point of the line.
Y This is the Y coordinate of the first point of the line.

LIN [PT2]: **X** This is the X coordinate of the second point of the line.
Y This is the Y coordinate of the second point of the line.

When all of the data is entered, and **Enter** is pressed, the system calculates the intersection of the line and the arc, and the radius value of the arc. The point is entered automatically into the correct data fields.

F5: ARC [CNTRPT] : TANTO ARC [CNTRPT & R]

This command finds the intersection point of an arc, defined by its centerpoint, and a tangent arc, defined by its centerpoint and radius. Figure E-21 shows how the two arcs are defined. Remember, that the calculated point in this command is the intersection of the two arcs, shown in Figure E-21 as a •.

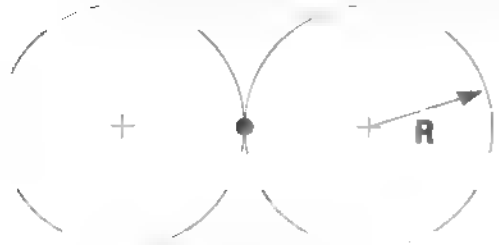


Figure E-21

Note: The two arcs can be positioned so that the first arc is inside the second arc, or so that it is outside the second arc. This is shown in Figure E-22.

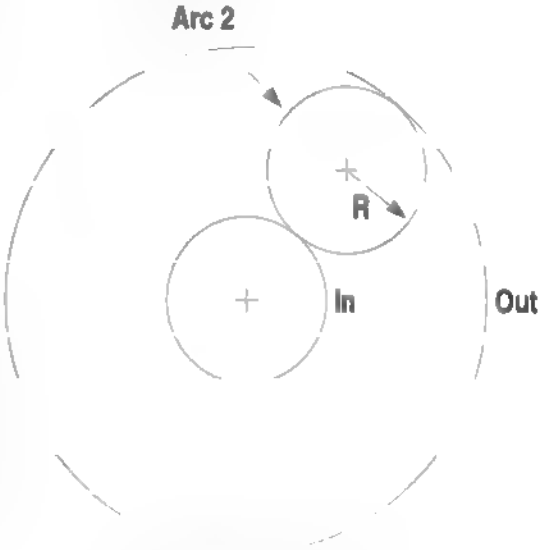


Figure E-22

In Figure E-22, **Arc 2** is shown with a defined radius. The other arc (Arc 1) is shown in two different positions, one labeled **In** the other labeled **Out**. The difference between these is the point at which Arc 1 intersects Arc 2. If the intersection is between the two arc centers, it is called **In**. If the intersection point of the two arcs is not between the two centers, then it is **Out**. This is used to identify which of the two possible arcs is the correct one.

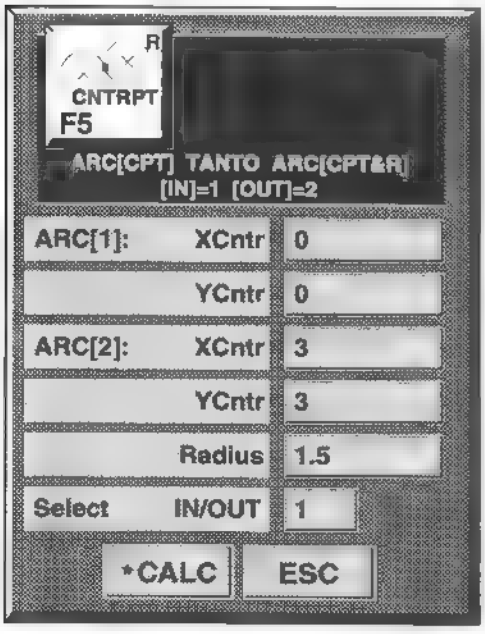


Figure E-23

Figure E-24

In the example shown in Figure E-24, the desired arc is **In**. This arc is selected by entering a **1** in the **Select IN/OUT** parameter, shown in Figure E-23.

ARC[1]:	**XCntr**	This is the X coordinate of the arc's centerpoint.
	YCntr	This is the Y coordinate of the arc's centerpoint.
ARC[2]:	**XCntr**	This is the X coordinate of the arc's centerpoint.
	YCntr	This is the Y coordinate of the arc's centerpoint.
	Radius	This is the radius value of the second arc.
Select	**IN / OUT**	This parameter chooses whether the first arc is inside the second arc, or outside.

When all of the data is entered, and **Enter** is pressed, the system calculates the intersection of the two arcs, and the radius value of the first arc. The coordinates of the point are entered automatically into the correct data fields of the command.

F6: ARC [R] : THRU PT TANTO LN [THRU 2 PTS]

This command finds the intersection point of an arc, defined by its radius and a point on the arc, and a tangent line, defined by two points on the line. Figure E-25 shows how the arc and the line are defined. The calculated intersection point is shown with a •.

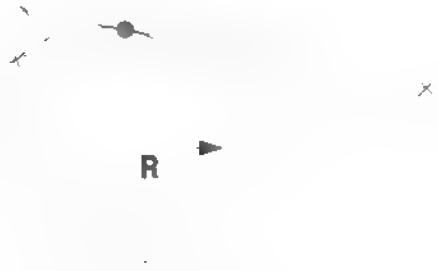


Figure E-25

Figure E-26

Note: The arc can be positioned so that its direction may be either clockwise or counter-clockwise. This is shown in Figure E-26. The direction is determined by moving from the defined point towards the tangent point of the line and arc.

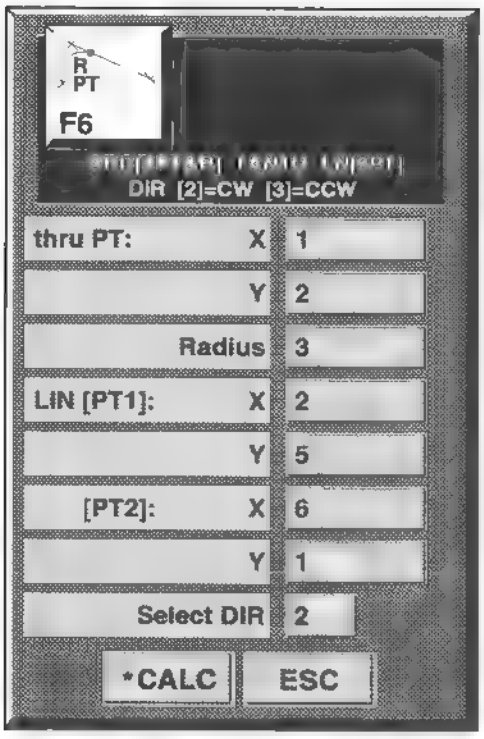


Figure E-27

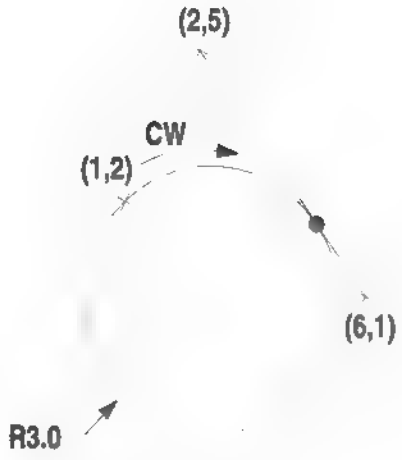


Figure E-28

thru PT:	**X**	This is the X coordinate of the point on the arc.
	Y	This is the Y coordinate of the point on the arc.
	Radius	This is the radius value of the arc.
LIN [PT1]:	**X**	This is the X coordinate of the first point on the line.
	Y	This is the Y coordinate of the first point on the line.
LIN [PT2]:	**X**	This is the X coordinate of the line's second point.
	Y	This is the Y coordinate of the line's second point.
Select	**DIR**	This parameter chooses the direction of the arc, either clockwise, or counter-clockwise.

When all of the data is entered, and **Enter** is pressed, the system calculates the intersection of the line and the arc (the arc direction is also shown), and the arc centerpoint. These points are displayed as shown in Figure E-29, so that it one can be selected as a location in the programmed instruction. To select one of the two points, enter the number of the desired point, (either **1** or **2**) in the box shown below the points in Figure E-29. The chosen point coordinates are entered automatically into the correct data fields, when the **Enter** key is pressed. If the calculated points are incorrect, press **0** then press **Enter**.

Figure E-29

9: INTOF: 2 LNS [THRU 2 PTS]

This command finds the intersection point of two lines. Each of the two lines is defined by two points. This is shown in Figure E-30.

Figure E-30

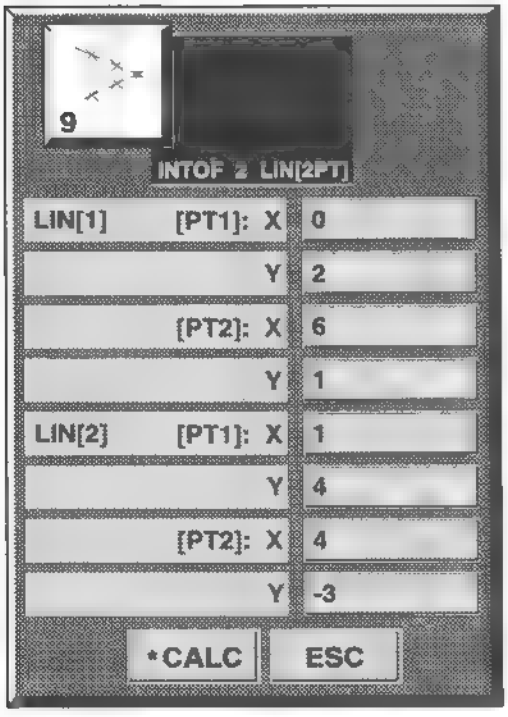


Figure E-31

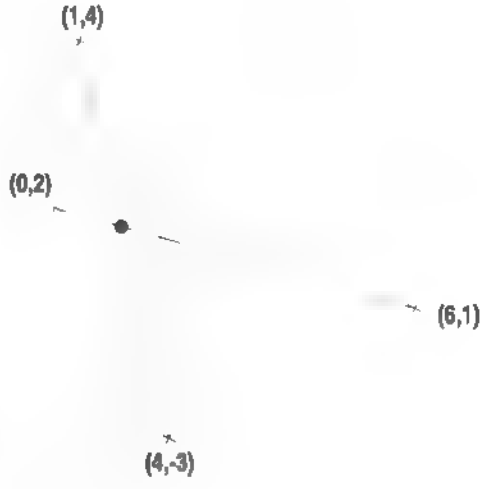


Figure E-32

LIN1 [PT1]:	**X**	This is the X coordinate of the first point on line 1.
	Y	This is the Y coordinate of the first point on line 1.
LIN1 [PT2]:	**X**	This is the X coordinate of the second point on line 1.
	Y	This is the Y coordinate of the second point on line 1.
LIN2 [PT1]:	**X**	This is the X coordinate of the first point on line 2.
	Y	This is the Y coordinate of the first point on line 2.
LIN2 [PT2]:	**X**	This is the X coordinate of the second point on line 2.
	Y	This is the Y coordinate of the second point on line 2.

When all of the data is entered, and **Enter** is pressed, the system calculates the intersection of the two lines. The point is entered automatically into the correct data fields of the command.

8: INTOF: LN [THRU PT] ATANGL TO LN [THRU 2 PTS]

This command finds the intersection point of a line, defined by two points on the line, and a second line, defined by a point on the line, and the angle between the two lines. An example of this is shown in Figure E-33.

Figure E-33

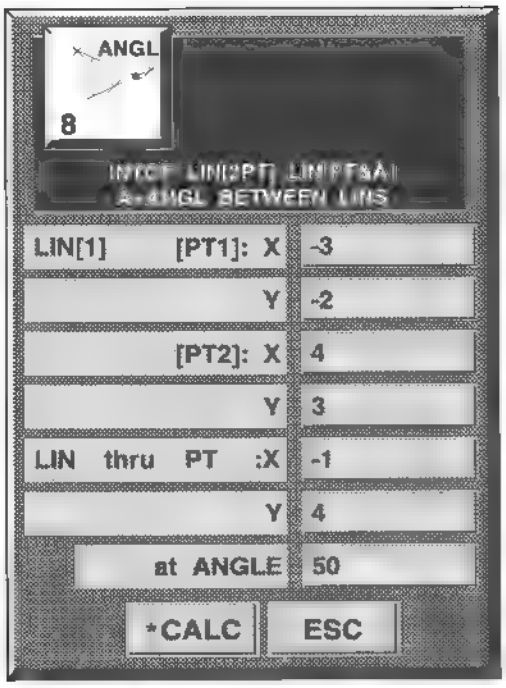


Figure E-34

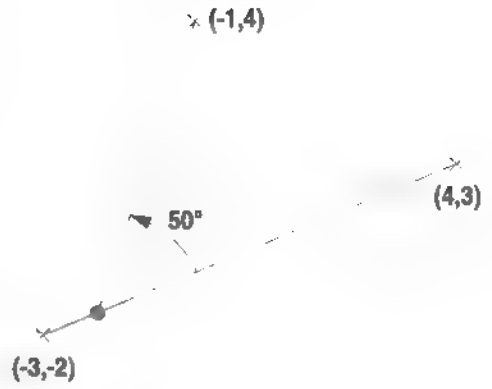


Figure E-35

LIN1 [PT1]: X This is the X coordinate of the first point on line 1.
Y This is the Y coordinate of the first point on line 1.

[PT2]: X This is the X coordinate of the second point on line 1.
Y This is the Y coordinate of the second point on line 1.

LIN thru PT: X This is the X coordinate of the point on line 2.
Y This is the Y coordinate of the point on line 2.

at ANGLE This is the angle between line 1 and line 2.

When all of the data is entered, and **Enter** is pressed, the system calculates the intersection of the two lines. The point is entered automatically into the correct data fields of the command.

7: INTOF: LN [THRU 2 PTS] & ARC [CNTRPT & R]

This command finds the intersection points of a line, defined by two points, and an arc, defined by its centerpoint and radius. See Figure E-36.

Figure E-36

Note: This command calculates two point locations, giving the user a choice between the two. The two calculated points are shown in Figure E-39.

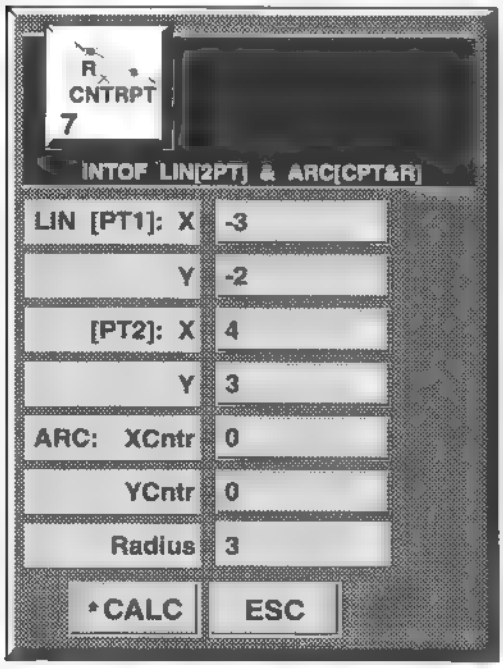


Figure E-37

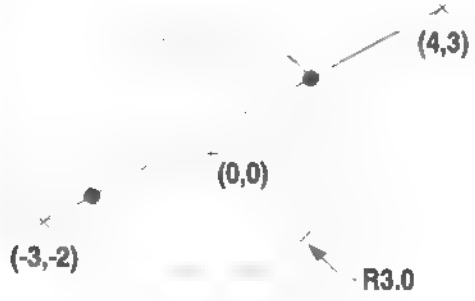


Figure E-38

LIN [PT1]:
- **X** — This is the X coordinate of the first point of the line.
- **Y** — This is the Y coordinate of the first point of the line.

LIN [PT2]:
- **X** — This is the X coordinate of the second point of the line.
- **Y** — This is the Y coordinate of the second point of the line.

ARC:
- **XCntr** — This is the X coordinate of the arc's centerpoint.
- **YCntr** — This is the Y coordinate of the arc's centerpoint.
- **Radius** — This is the radius value of the arc.

When all of the data is entered, the system calculates the two intersection points for the line and arc. The coordinates of the two points are displayed as shown in Figure E-39. One of these points can be chosen as a location in the programmed instruction. To select one of the two points, enter the number of the desired point, (either **1** or **2**) in the box shown below the points in Figure E-39. The chosen point coordinates are entered automatically into the correct data fields, when the **Enter** key is pressed. If the calculated points are incorrect, press **0** then press **Enter**.

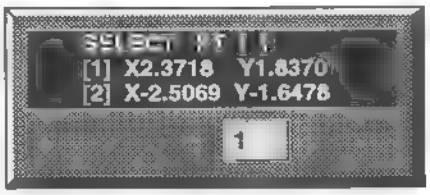


Figure E-39

6: INTOF: LN [THRU 2 PTS] & ARC [THRU 2 PTS & R]

This command calculates the intersection points of a line, defined by 2 points, and an arc, defined by two points on the arc and its radius value. This command returns two intersection points, because the line and arc intersect in more than one location. An example of this is shown in Figure E-40. The user is given a choice of the two points to use as a location in a program or DO EVENT command.

Figure E-40

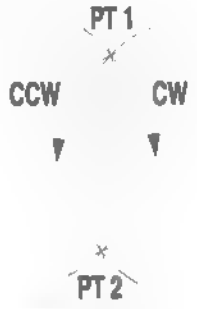


Figure E-41

Note: The direction of the arc must be specified as one of the parameters in this command. The direction is determined by moving around the arc from point 1 to point 2. The direction of this movement determines the direction of the arc. An example of this is shown in Figure E-41.

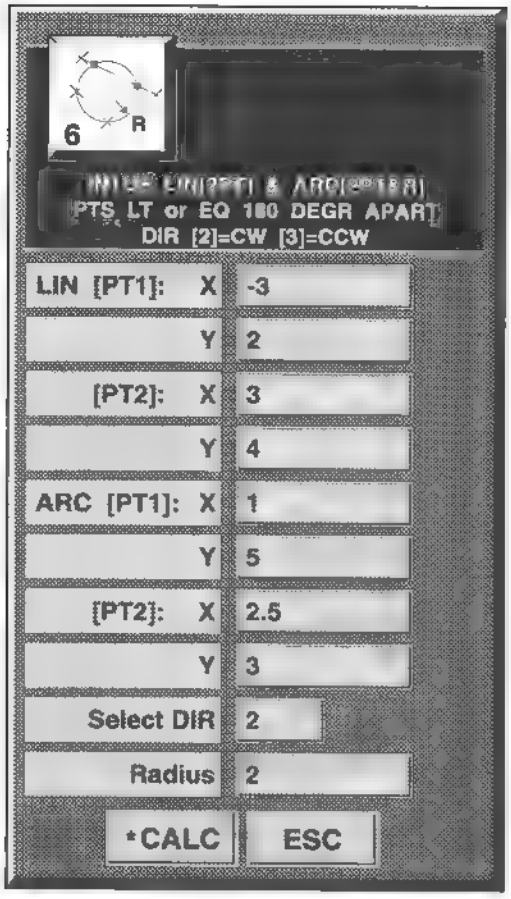


Figure E-42

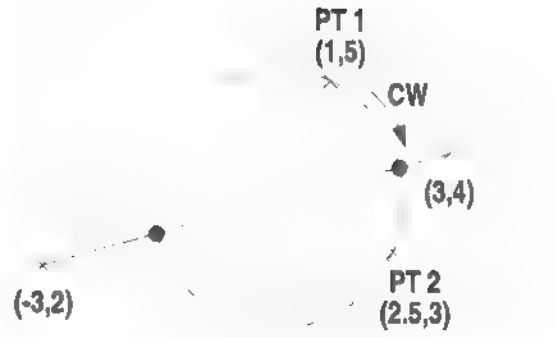


Figure E-43

LIN [PT1]: X This is the X coordinate of the first point of the line.
Y This is the Y coordinate of the first point of the line.

[PT2]: X This is the X coordinate of the second point of the line.
Y This is the Y coordinate of the second point of the line.

ARC: [PT1]: X This is the X coordinate of the first point of the arc.
Y This is the Y coordinate of the first point of the arc.

[PT2]: X This is the X coordinate of the second point of the arc.
Y This is the Y coordinate of the second point of the arc.

Select DIR This is the direction of the arc.

Radius This is the radius of the arc.

When all of the data is entered, the system calculates the two intersection points of the arc and line. The coordinates of the two points are displayed as shown in Figure E-44. One of these points can be chosen as a location in the programmed instruction. To select one of the two points, enter the number of the desired point, (either **1** or **2**) in the box shown below the points in Figure E-44. The chosen point coordinates are entered automatically into the correct data fields, when the **Enter** key is pressed. If the calculated points are incorrect, press **0** then press **Enter**.

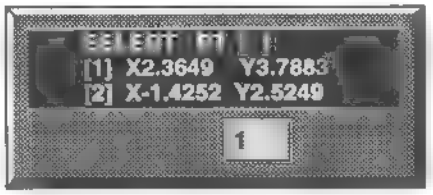


Figure E-44

5: INTOF: 2 ARCS [CNTRPT & R]

This command finds the intersection points of two arcs, each defined by its centerpoint and radius.

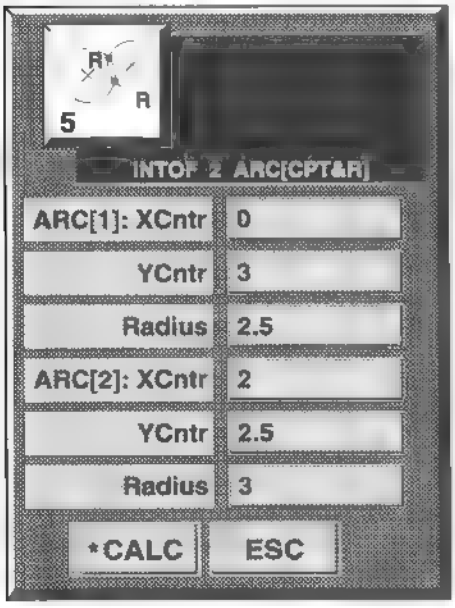


Figure E-46

Figure E-45

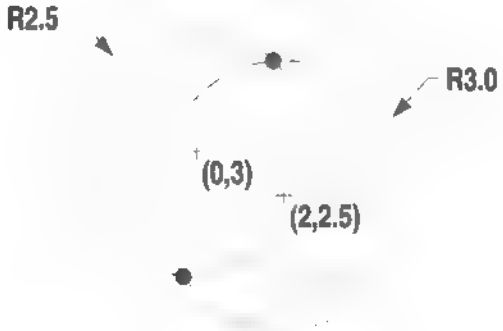


Figure E-47

ARC[1]:	**XCntr**	This is the X coordinate of the first arc's centerpoint.
	YCntr	This is the Y coordinate of the first arc's centerpoint.
	Radius	This is the radius value of the first arc.
ARC[2]:	**XCntr**	This is the X coordinate of the second arc's center.
	YCntr	This is the Y coordinate of the second arc's center.
	Radius	This is the radius value of the second arc.

When all of the data is entered, the system calculates the two intersection points of the two arcs. The coordinates of the two points are displayed as shown in Figure E-48. One of these points can be chosen as a location in the programmed instruction. To select one of the two points, enter the number of the desired point, (either **1** or **2**) in the box shown below the points in Figure E-48. The chosen point coordinates are entered automatically into the correct data fields, when the **Enter** key is pressed. If the calculated points are incorrect, press **0** then press **Enter**.

Figure E-48

4: CNTRPT: ARC [THRU 2 PTS w ANGL BETWEEN PTS]

This command calculates the centerpoint location of an arc, defined by two points on the arc, and the angle between them. Figure E-49 shows how the arc is defined. **Note:** The angle must be less than or equal to 180°.

Figure E-49

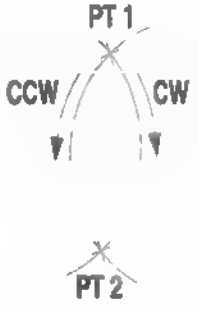


Figure E-50

Note: The direction of the arc must be specified as one of the parameters in this command. The direction is determined by moving around the arc from point 1 to point 2. The direction of this movement determines the direction of the arc. An example of this is shown in Figure E-50.

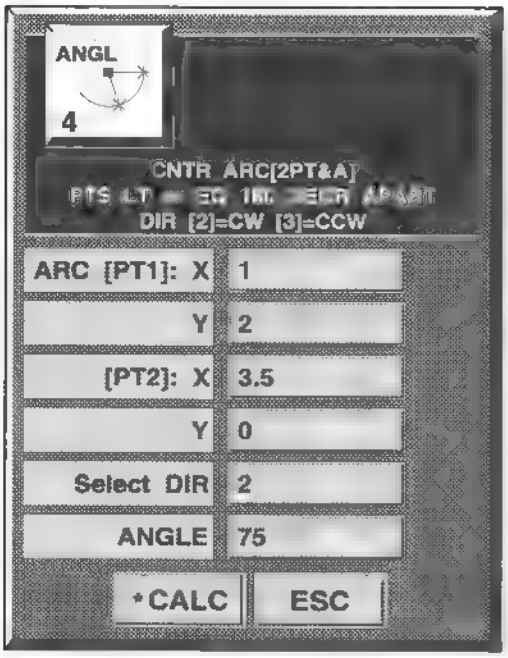


Figure E-51

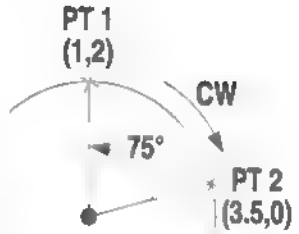


Figure E-52

ARC: [PT1]: X This is the X coordinate of the first point of the arc.
Y This is the Y coordinate of the first point of the arc.

[PT2]: X This is the X coordinate of the second point of the arc.
Y This is the Y coordinate of the second point of the arc.

Select DIR This is the direction of the arc.

ANGLE This is the angle between the two points.

When all of the data is entered, the system calculates the centerpoint of the arc. The coordinates of the point are automatically placed in the correct data fields of the command from which **/GEO** was selected.

3: CNTRPT: ARC [THRU 2 PTS & R]

This command finds the centerpoint location of an arc defined by two points on the arc, and the radius value of the arc. Figure E-53 shows how the arc is defined. **Note:** The two points on the arc must be less that 180° apart.

Figure E-53

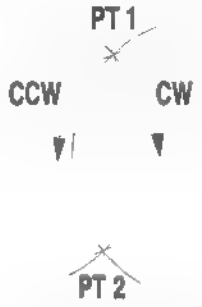


Figure E-54

Note: The direction of the arc must be specified as one of the parameters in this command. The direction is determined by moving around the arc from point 1 to point 2. The direction of this movement determines the direction of the arc. An example of this is shown in Figure E-54.

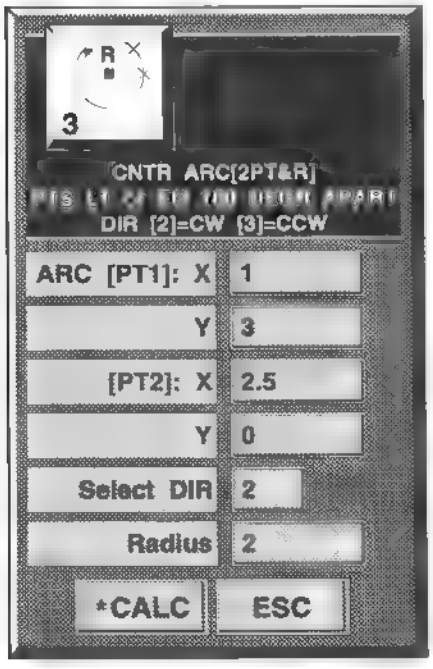


Figure E-55

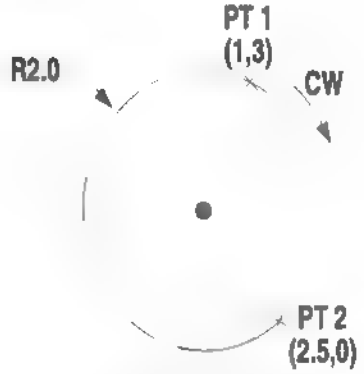


Figure E-56

ARC:	**[PT1]:**	**X**	This is the X coordinate of the first point of the arc.
		Y	This is the Y coordinate of the first point of the arc.
	[PT2]:	**X**	This is the X coordinate of the second point of the arc.
		Y	This is the Y coordinate of the second point of the arc.
		Select DIR	This is the direction of the arc.
		Radius	This is the radius of the arc.

When all of the data is entered, the system calculates the centerpoint of the arc. The coordinates of the point are automatically placed in the correct data fields, when the **Enter** key is pressed.

2: CNTRPT: ARC [THRU 3 PTS]

This command finds the centerpoint of an arc defined with three points.

Figure E-57

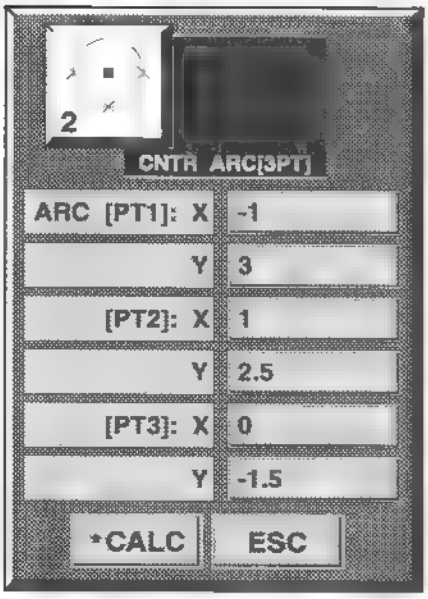


Figure E-58

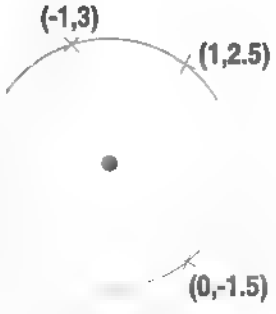


Figure E-59

ARC:	**[PT1]:**	**X**	This is the X coordinate of the first point of the arc.
		Y	This is the Y coordinate of the first point of the arc.
	[PT2]:	**X**	This is the X coordinate of the second point of the arc.
		Y	This is the Y coordinate of the second point of the arc.
	[PT3]:	**X**	This is the X coordinate of the third point of the arc.
		Y	This is the Y coordinate of the third point of the arc.

When all of the data is entered, the system calculates the centerpoint of the arc. The coordinates of the point are automatically placed in the correct data fields, when the **Enter** key is pressed.

1: POLAR: R A XC YC

This command calculates the X Y coordinates for a point that is specified using polar coordinates from a specified pole location. Figure E-60 shows how the polar coordinates are defined.

Note: The coordinates of the pole location (XC, YC) must be given in XY coordinates.

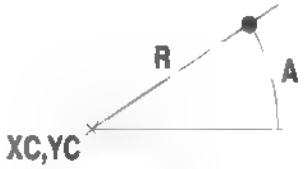


Figure E-60

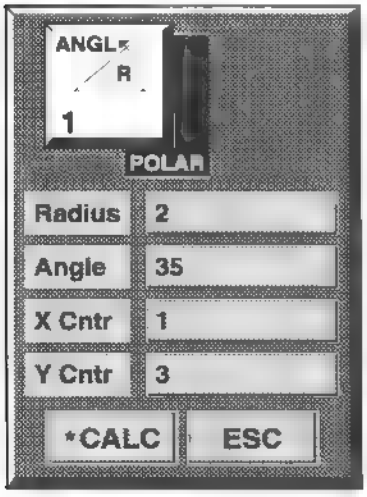


Figure E-61

Angle	This is the angle of rotation from the X axis. This is shown in Figure E-60 as the angle marked **A**.
Radius	This is the radius of the arc.
XCntr	This is the X coordinate of the pole location.
YCntr	This is the Y coordinate of the pole location.

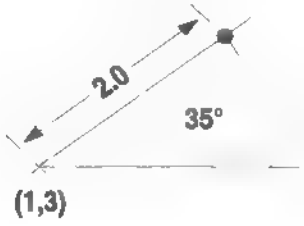


Figure E-62

When all of the data is entered, and **Enter** is pressed, the system calculates the XY coordinates of the point. The coordinates of the point are entered automatically into the correct data fields of the command.

0: MIDPT| LN[THRU 2PTS]

This command calculates the midpoint of a line which is given by its two endpoints. The coordinates of the two endpoints of the line must be entered, and the EZ-TRAK finds the mid-point of the line. Figure E-63, below shows an example of the mid-point command.

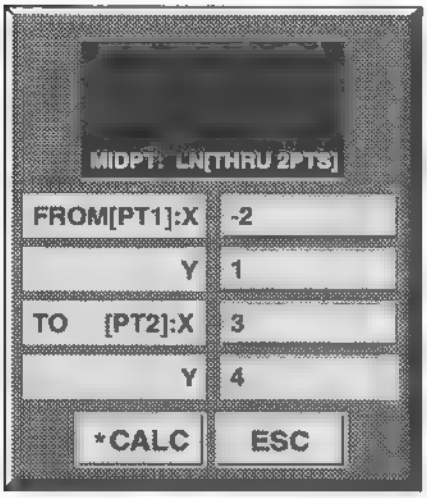


Figure E-63

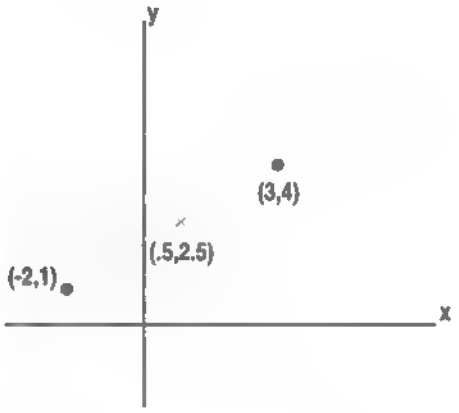


Figure E-64

ESC Pressing the **ESC** key exits the GEOMETRY HELP menu, and returns to the command in which the **/GEO** key was pressed.

Appendix F
FEEDS & SPEEDS CALCULATOR

Introduction

This section of this manual discusses the use of the **FEEDS/SPEEDS** functions that are available in many of the DO EVENT and MDI commands in the EZ-TRAK software.

Calling up the FEEDS/SPEEDS screen

The **FEEDS / SPEEDS CALCULATOR** screen is called up when the **F6** key is pressed while entering data into one of the DO EVENT or MDI milling commands. When the FEEDS/SPEEDS screen is called, the screen displays the information shown in Figure F-1.

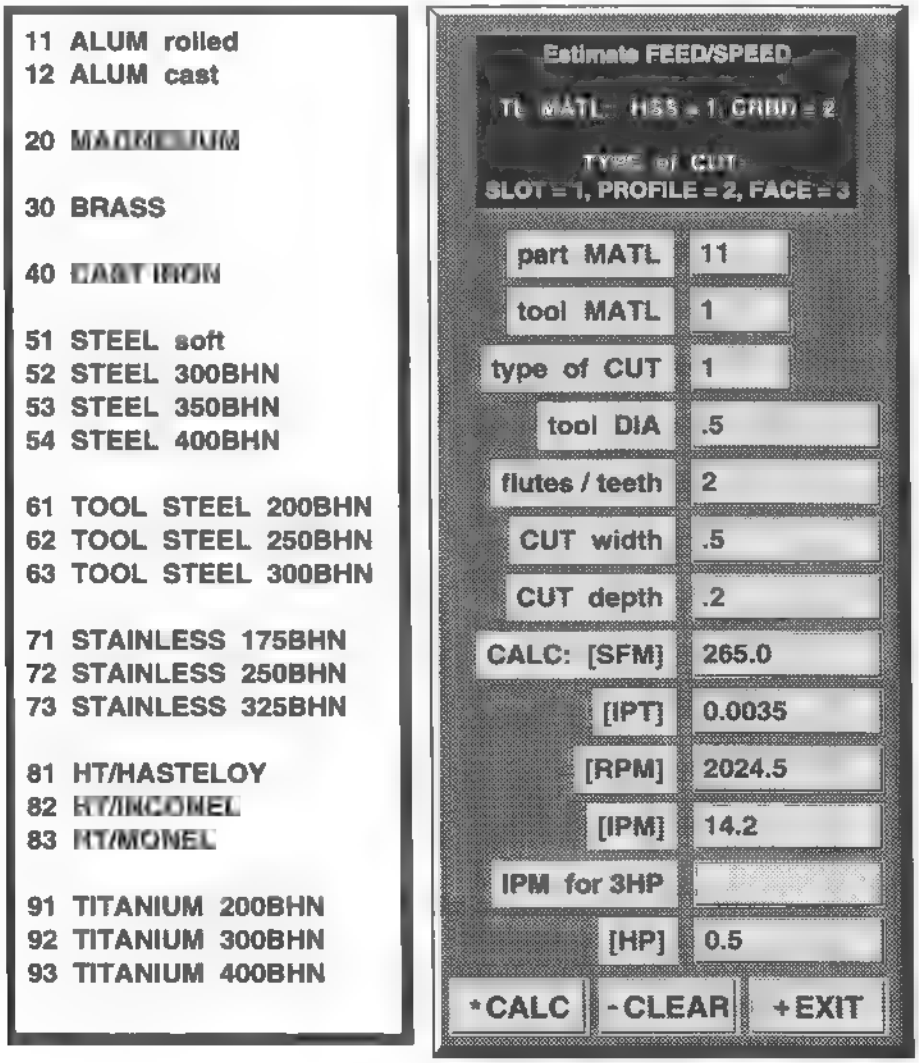


Figure F-1

Using the FEEDS/SPEEDS Calculator

The FEEDS/SPEEDS calculator is provided as a quick way to estimate the necessary spindle speed, and feedrate for any machining instruction that is programmed on the EZ-TRAK.

NOTE: The values calculated by the FEEDS/SPEEDS calculator are only a starting point. Depending on the work material, the sharpness of the tool, and other variables, the calculated feedrates may not be appropriate for every application. Always double check the calculated spindle speed and feedrate before proceeding with the machining instruction.

Entering the FEEDS/SPEEDS data

The FEEDS/SPEEDS calculator requires some information before it can calculate the spindle speed and feedrate.

part MATL	This is the type of material that is being cut. Find the material type, or a material with a similar hardness value in the list at the left. Enter the number here.
tool MATL	This is the kind of tool being used. This is either **High-Speed Steel** (HSS) or **Carbide** (CRBD). Enter **1** if you are using an HSS tool, **2** if it is CRBD.
type of CUT	This is the kind of cut being made, either **SLOT**, **PROFILE**, or **FACE**. Enter **1** for a SLOT, **2** for a PROFILE, or **3** for a FACE.
tool DIA	Enter the tool diameter here.
flutes / teeth	Enter the number of flutes, or teeth on the tool here.
CUT width	Enter the width of the cut here. If it is a **SLOT** cut, then enter the tool diameter here also.
CUT depth	Enter the depth of the cut here.

When all of the data is entered, the calculator automatically calculates the feedrate, and spindle speed. The calculated values are shown in the lower half of the FEEDS/SPEEDS window.

CALC:	**[SFM]**	Surface Feet per Minute - This shows the feedrate relative to the surface of the part.
	[IPT]	Inches Per Tooth - This shows the amount of material cut by each tooth of the tool as it rotates, and cuts the material at the given feedrate and spindle speed.

[RPM] Revolutions Per Minute - This is the calculated spindle speed for the programmed data. This is the speed which the operator is prompted to set before the instruction is executed.

[IPM] Inches Per Minute - This is the feedrate entered into the program line.

[IPM for 3HP] Inches Per Minute for 3 Horsepower - this is the maximum feedrate that the EZ-TRAK SX could use to cut the programmed instruction given the entered values. At this feedrate, the spindle motor would be operating at its maximum horsepower rating.

[HP] Horsepower - This is the approximate horsepower necessary to cut the programmed instruction at the IPM feedrate.

In several instructions, more than one feedrate can be programmed. The pocket commands, and the COMPON move can be programmed to make a finishing pass after the initial roughing has been completed. These instructions can include a second feedrate for producing a smoother finish than the roughing operation created. The Feeds & Speeds Calculator can be used to calculate both feedrate values.

NOTE: Using the combination of a **carbide** tool bit, and a **slot** cut will cause the Feeds & Speeds calculator to return a feedrate of zero (0.0), since this is considered unacceptable machining practice.

Appendix G
COMMON ERROR MESSAGES

Introduction

This section is a listing of most of the messages that can appear at any time on the EZ-TRAK screen. A description of when the message would occur and what the message means is included as well.

Messages

>> SAVED PT point-number

This message appears during TEACH mode immediately after a mill or drill point is entered into the points list. It displays the point number in the points list that the mill or drill point was saved under.

ENTER [0] TO CLR PTS
ENTER [ ] to CANCEL

These messages are displayed when the operator selects "1CLRPTS" from the TEACH mode button panel. The operator is prompted to confirm or cancel the operation. A clear points operation can be cancelled by leaving the data entry area blank or confirmed by entering in a zero (0).

>> CLR SAVED PTS

This message is displayed in the TEACH mode message window in the lower left corner of the screen (just below the large coordinate window) when the operator selects "1 CLRPTS" from the TEACH button panel.

NEW PTS FILE

This message is displayed in TEACH mode whenever the points list is empty. The points list can be empty when the operator first enters TEACH mode or immediately following the execution of a clear points command.

LAST SAVED PT point-number

This message is displayed in the mode message window (in the lower left corner of the display) whenever a point is entered into the points list window. It lets the operator know the point number of the last saved point. Up to 100 points can be saved in the points list.

INTOF 2 LNS
ENTER NUM of 1stPT on 1stLN
ENTER NUM of 2ndPT on 1stLN
ENTER NUM of 1stPT on 2ndLN
ENTER NUM of 2ndPT on 2ndLN

These messages are displayed when "<- INTOF" is selected (computes the intersection point of 2 lines) in TEACH mode. The operator is prompted to enter the point numbers of the 2 points that define the first line and the point numbers of the 2 points that define the second line.

INTOF 2LNS: Xx-value Yy-value
ENTER NUM TO SAVEPT or [.] =MOVETO PT

These messages apply during TEACH mode when the operator selects "<- INTOF". They appear after the operator enters in the point numbers of the 2 intersecting lines. The X and Y coordinates of the calculated intersection point is displayed and the operator is prompted to enter the point number in the save points list to save it, or enter " . " to move the spindle to the intersection point coordinates.

CNTR [3PTS ON ARC]
ENTER NUM of 1stPT on ARC
ENTER NUM of 2ndPT on ARC
ENTER NUM of 3rdPT on ARC

This message is displayed when "->CRCNTR" is selected in TEACH mode. The CRCNTR function calculates the center of an arc defined by 3 points. The operator is prompted to enter the point numbers of the points in the saved points list that define the arc.

CNTR [3PTS ON ARC]: Xx-value Yy-value Rradius-value
ENTER NUM TO SAVEPT or [.] =MOVETO PT

These messages are displayed n TEACH mode when "-> CRCNTR" is selected from the save points button panel and after supplying the point numbers of the points that define the arc. The X and Y coordinates of the calculated arc center and radius are displayed and the operator is prompted to either enter the point number in the save points list to save it, or enter " . " to move the spindle to the arc center point coordinates.

PLEASE ENTER 1 FOR MILL
AND 0 FOR DRILL

This message is displayed in TEACH mode immediately before the calculated intersection or circle center point is to be saved in the points list. The operator is prompted to enter the point type (mill or drill) to save it as.

MOVETO PT
ENTER PT [ ]

This message is displayed in TEACH mode when ".MOVPTS" is selected from the save points mode button panel. The operator is prompted to enter the point number of the point to move the spindle to.

ERROR – NO POINT AT point-number

This message applies when ".MOVPTS" has been selected from the TEACH button panel and the number of the point to move to has just been entered. It appears when there is no points list entry at the specified point number.

MOVETO X=x-coordinate Y=y-coordinate
[.] = MOVETO PT

This message is displayed when ".MOVPTS" is selected from the TEACH button panel and the number of the point to move has just been entered. The X and Y coordinates of the point to move to is displayed and the operator is prompted to confirm the move. The move can be aborted by leaving the edit field blank.

WAIT [MOVE]

This message is displayed while the spindle is moving to a saved point in TEACH mode after selecting ".MOVPTS". It informs the operator to wait until the move completes before making another key selection.

CAN'T DO MOVE WITH POWER OFF

This message is displayed after ".MOVPTS" has been selected in TEACH mode. The operator tried to do a move with the axis drives off. In order to do the move, he must first exit TEACH mode, select "1 JOG X", re-enter TEACH mode, select ".MOVPTS" and then re-select the point number to move to.

>>SAVE PTS [MANUAL]

This message is displayed when TEACH mode is entered after turning power off. It informs the operator that there is no power to the axis drives and that certain operations such as ".MOVPTS" can not be performed with power off. The operator must manually move to the desired point.

>>SAVE PTS [JOG X]

this message is displayed when TEACH mode is entered by first selecting "1 JOG X" from the main button panel and then selecting ".SAVPTS".

[TURN ON SPINDLE TO ENABLE CYCLE START]

The operator will receive this message if he tries to perform a cutting operation with the spindle off.

>> WAIT [CYCLE]

This message appears when the axes are in motion or during a Z positioning move. It informs the operator to wait until the cycle completes before selecting another function.

ABORT EVENT

This message is displayed when the escape key is pressed during a DO EVENT mill or drill operation.

STEP = .0005

This message is displayed in JOG mode and shows the step increment to jog in inches or millimeters. The axes are moved by the step increment each time the "->" or "<-" keys are pressed. Pressing "->" will step .0005 inches in the positive X or Y direction (depending on whether JOG X or JOG Y was selected) and "<-" will step .0005 in the negative X or Y direction.

ALARM
HIT [ANYKEY] TO CLEAR

This message appears when the machine enters into an alarm state. A message describing the alarm condition will also appear beside this message. The operator can clear the alarm and remove the message from the display be striking any key.

MOVE DONE

This message is displayed whenever a DO EVENT move is completed.

SCANNING PATH... *.PGM
SCANNING PATH... *.TXT

This message appears immediately after the operator selects "5 EDIT" from the main button panel or "<- LOAD" from RUN mode. The root directory on the C:\ or A:\ drive (depending on whether "F5 change to drive A:" has been selected) is searched for all file names having the "PGM" or "TXT" extensions (depending on whether "F4 MORE FILES" has been selected). After the file search completes, the operator is presented with a list of files to choose from. This message informs the operator to wait until the file search on the A:\ or C:\ drive has completed.

NO FILES FOUND *.PGM
NO FILES FOUND *.TXT

This message appears if, after the root directory on the A:\ or C:\ drive has been searched for PGM or TXT files, no files were found having the "PGM" or "TXT" extensions.

>>INPUT DATA

This prompt appears in the prompt window in the upper right corner of the display during any data entry operation. It informs the operator that he is in data entry mode.

SET OFFSETS

This message is displayed immediately after the X, Y, Z coordinates are entered for "7 SET X, Y, Z". It lets the operator know that the coordinates for the current spindle position are being changed.

>>DO MOVE

This message is displayed in the upper right corner of the "3 MOV ABS" display. It lets the operator know that he is in MOVE ABS mode.

MOVE Z @ z-coordinate

This message appears at the bottom of the "3 MOV ABS" and "6 MOV INC" displays. It reminds the operator to change Z to the desired position before executing the move.

MOVE ABS Xx-coordinate Yy-coordinate
MOVE INC Xx-coordinate Yy-coordinate

This message appears in the center of the "3 MOV ABS" display. It displays the X and Y coordinates to move to, the move mode (ABS or INC), and a "+MOVE" and an ESC button. The operator presses "+" to execute the move or escape to abort the move.

WAIT [MOVE]

This message appears in the top right corner of the "3 MOV ABS" and "6 MOV INC" displays. It tells the operator to wait until the move finishes executing before selecting another function.

CAN'T DO MOVE WITH POWER OFF

This message should never be displayed. The only time it is displayed is when the axis drives are down.

WAIT — LOADING PARAMS

This message is displayed immediately following boot-up upon first entering the EZ-TRAK main screen. It informs the operator that the machine parameters and user parameters are being loaded from the systems disk into the EZ-TRAK software. The user parameters are the last part program the operator was working with and the measurement units that all of the values were in (inch or mm).

WAIT — SAVING PARAMS

This message is displayed whenever the machine parameters and user parameters are saved on floppy disk. This happens when the operator exits EZ-TRAK to utilities or when he changes from inch mode to metric mode or visa versa. This is done so that when he comes back into EZ-TRAK the part program he last worked with will automatically be loaded into memory and all values will be displayed in the measurement mode he last worked in.

FIND SEQNO sequence-number

This message appears when the operator selects "3 FND SEQ" from RUN mode showing the sequence number to search for in the part program.

FIND TOOLNO tool-number

This message appears when the operator selects "3 FND SEQ" from RUN mode showing the tool number to search for in the part program.

Could not locate sample MW font

EZ-TRAK uses special fonts to draw the graphics characters such as up and down arrows. These graphics characters are taken from font files located on the EZ-TRAK system disk. This message is displayed if any of the following font files are not present on the system diskette:

HLV050B.FN_
HLV025B.FN_
BLD019M.FN_
BLD019B.FN_
BLD013.FN_
BLD015.FN_

Error loading sample MW font
Error loading sample MW font 1
Error loading sample MW font B
Error loading sample MW font X
Error loading sample MW font 0

EZ-TRAK uses special fonts to draw the graphics characters such as up and down arrows. These graphics characters are taken from font files located on the EZ-TRAK system disk. These messages are displayed if:

1) There is not enough program memory to store the font file contents.
2) One or more of the sectors on drive C:\ used to store the information in the font file are bad.

PRGM pgm-name LOADED

This message states that the specified part program has been successfully loaded into the BMDC card to be executed.

EXIT EZ-TRAK

This message is displayed whenever the operator exits EZ-TRAK into utilities.

Attempt to write to a write-protected disk

An attempt was made to write a part program to a write-protected floppy disk. Check that the button on the back of the disk is set to the write position.

Drive not ready

A floppy disk could not be found in drive A:\. Check that there is a floppy disk in the disk drive, that the disk is pressed in, and that the drive door is closed all the way.

Write fault

An error was detected while writing to a floppy or hard drive. Run a diagnostic test on the floppy or hard drive.

Read fault

An error was detected while reading from a floppy or hard drive. Run a diagnostic test on the floppy or hard drive.

END OF PROGRAM

This message is displayed while previewing a part program when the end of the program has been reached. It informs the operator that preview has completed.

OPERATOR STOP

The operator receives this message when an optional stop (||STOP) has been encountered while previewing a part program and the operator selects "0" to STOP preview (instead of "+" to continue previewing).

TOOL CHANGE

This message appears at the bottom of the preview window whenever a tool change PGM statement has been encountered. Preview pauses to allow the operator to change the tool diameter, re-size the preview window, etc.

PROGRAM STOP

This message is displayed when an optional stop (||STOP) has been encountered in a part program while it is being previewed. The operator is then given the option of continuing the part program or making a function key selection.

PROGRAM ERR

This message is displayed when an alarm occurred while previewing a part program. A typical alarm situation would be moving outside the maximum travel limits, for example.

FAULT: EZ-LINK communications aborted

This message is displayed when the operator selects "9 UTILS" from EZ-TRAK and then "<7> SEND OR RECEIVE FILES" from Utilities. A link could not be established between EZ-TRAK and a remote terminal.

Communication Error
Remote Cancel

This message is displayed when the communications link between EZ-TRAK and a remote terminal was cancelled by the remote terminal.

User Cancel

The operator receives this message after "9 UTILS" has been selected and a communications link has been established. It is displayed when the operator hits escape during a send or receive operation.

File Write Error

The operator receives this message during a send or receive operation in "9 UTILS". EZ-TRAK could not write the data for the file being sent to the destination machine or could not write the data for the file being received to the receiving machine.

File Read Error

This message appears in "9 UTILS" if an I/O error occurs while sending or receiving a file. Check the disk sectors being used for the file being sent or received on the sending machine if you are sending a file and on the remote machine if you are receiving a file.

WARNING!!
WRITE PROTECT the original disk before copying.

This message appears as a safety precaution to protect the original disk before the copy operation takes place.

NOTE: COPY will involve swapping the original disk and the blank disk 3 times.

This message informs the operator of what the disk copy operation involves.

HIT <+> TO DISKCOPY

This prompts the operator for confirmation and gives him a chance to bail out of the disk copy operation.

COPY disk in FLOPPY DRIVE

This message appears when the operator elects to do a complete disk copy. This message lets him know that a complete disk copy is in progress.

ERROR: BREAK TRAP NOT SET

This message is when "<7> SEND or RECEIVE files" has been selected, followed by "<3> ASCII" or "<2> YMODEM" and a link could not be established between EZ-TRAK and a remote terminal. Specifically interrupt signal handling (ISH) could not be set. ISH allows a send or receive operation to be aborted by hitting the escape key.

COM ERROR: COMM PORT 1 NOT SET

This message is displayed when there is a loose cable connection to port 1 or when the connection has not been established.

>>COMM PORT1 9600,8,NO,1 !! OPEN

This message appears when a successful link has been established. MODEMs with baud rates up to 9600 bits per second can be used.

ERROR: DESIGNATED FILE [PGM file-name] NOT FOUND
ERROR: DESIGNATED FILE [TXT file-name] NOT FOUND

The file to be sent could not be found on EZ-TRAK.

WAIT — SENDING protocol-type FILE [file-name] — HIT [ESC] TO ABORT

Where protocol type can be:

1. EZ-LINK – the communication format used by Bridgeport equipment.
2. YMODEM – a type of communication protocol.
3. ASCII – sends an ASCII file straight through without any modifications.

A send operation is in progress. To abort the operation, hit the escape key.

ERROR IN SENDING FILE

An error was encountered while attempting to send a file to a remote device.

DONE SENDING FILE file-name

This message notifies the operator that the send operation has completed successfully.

ERROR: Cannot Save Received File

The file that was received from a remote machine could not be saved on drive C:\. Make sure that drive C:\ can be written to.

Receive file terminated

This message notifies the operator that we are exiting the receive operation.

syntax ERR

This message is displayed when "* CALC" is selected from a data entry box in DO EVENT or MDI. It appears when an invalid calculation was typed in. An example of this would be typing in "7*" (without the number to the right of the multiplier operator) as a calculation.

( ) ERR

This message is displayed in "* CALC" when the number of parentheses on the left of an arithmetic expression is different from the number of parentheses on the right of the expression.

expr value ERR

This message appears in "* CALC" when ENTER was pressed without entering a value.

DIVISION BY ZERO ERROR

This message appears in "* CALC" when an expression in the denominator of a division operation evaluates to zero.

ERROR — EXPRESSION MUST BE POSITIVE

This message appears in "* CALC" when an expression inside a square root function evaluates to a negative number.

ERROR — INPUT FIELD EMPTY: CHECK DATA

This message appears whenever a data entry edit field was left blank.

INPUT LESS THAN 2 HOLES

This message appears when "7 DR ROW", "8 DR BOX" or "9 DR BC" has been selected and the number of holes to drill is less than 2. The minimum number of holes to drill for any of these selections is always 2.

CAN'T SELECT NUM EQ 0

This message is displayed whenever "3 GOTO N", "6 SET N", "9 ERASE", or "5 COPY" has been selected from EDIT and the operator has selected the very first line in the program. It is only a header line that identifies the PGM and contains information that can not be executed. If it were moved, the BMDC would do a reset program every time it encountered that header line. If it were removed, the BMDC would not know the measurement mode for the program (inch or metric).

DISPLAY LIST not opened

The DISPLAY.LST file could not be opened. This temporary file contains the point to point locations used by "* VIEW PART" function to draw the part. Make sure there is memory available on the C:\ drive.

NO MEMORY AVAILABLE

The machine ran out of program memory while attempting to display the file selection list for EDIT or LOAD.

A:\\ SYS.BEZ not opened

The system parameter file could not be found on drive A:\. Make sure that an EZ-TRAK system disk is in drive A:\ whenever re-entering EZ-TRAK from "9 UTILS". This file contains the current software revision level, the max travel limit in X, Y, Z, the X, Y, Z user offsets, the X, Y backlash values, and the X, Y lead screw compensations.

TEMP.TXT not opened

This message appears after selecting "+ DO PTS" from ".SAVPTS". The TEMP.TXT file (contains the GCODE for the TEACH.PGM) could not be opened. Make sure there is available memory on drive C:\.

TEACH.PGM not opened

The TEACH program that will contain the PGM for the saved points could not be opened. Make sure there is available memory on the C:\ drive.

PRGM LOAD FAILED

The operator receives this message when one of the following three errors occurred:

1. TEMP.TXT file could not be opened. Make sure there is available memory on drive C:\.
2. One of the following errors was encountered while attempting to write TEMP.TXT to the BMDC card:
    a) File is too big.
    b) BMDC error
    c) BMDC write error
3. An error was found while attempting to generate GCODE for the PGM file. Check the PGM file for a programming error.

STEP OVER LT .005

This message is displayed when:

1. The pocket step over for milling a rectangular pocket is less than .005 inches.
2. The Y-step over for a face milling operation is less than .005 inches.
3. The pocket step over for milling a circular pocket is less than .005 inches.

Z DEPTH LT .0001

Certain canned cycles require a Z depth. They are:

1. Mill Rectangle
2. Mill Rectangular Pocket
3. Face Mill
4. Slot Mill
5. Circle Mill

LINES ARE PARALLEL

This message applies to "<- INTOF" in TEACH mode. The lines defined by the selected saved point numbers never cross.

3 PTS ARE CO-LINEAR

This message applies to "-> CRCNTR" in TEACH mode. The selected saved points defining the arc form a straight line.

CYCLE DEFINED INCORRECTLY

This message is displayed when an edit field has been left blank. Make sure that all data entry fields have numbers in them.

HP INCORRECTLY CALCULATED

This message applies to a feeds and speeds calculation. The value entered for the part material or the tool material is unknown.

A:\\SYS.DAT not opened

This temporary file contains the last part program being worked with and the last measurement (inch or metric) being worked in. This message is typically displayed when a new EZ-TRAK systems disk has been sent out It is only an informational message and can be ignored.

ERROR — !UNEXPECTED EOF! SEQ

This message is displayed if a blend line or blend arc is the last PGM block in the program.

!ILLEGAL LAST MOVE IN COMP! SEQ
sequence-number [HIT KEY to CONTINUE]

This message is displayed if COMP ON, BL LIN, or BL ARC is the last PGM block in the program.

>> CHECK Z

This message reminds the operator to set Z at the proper position before executing a DO EVENT move.

SET POWER OFF TO SAVE PTS

This message appears when TEACH mode has been entered from the main button panel. In this mode, the axis drives must be off to save a point. To save a point with power on, select ". SAVPTS" from the jog menus.

HIT HOLD BEFORE EXIT

This message is displayed in AUTO run mode when the operator selects "0 EXIT" while the axes are still in motion.

EXIT ON MOVE DONE

This message is displayed in BLOCK run mode when the operator selects "0 EXIT" while the axes are still in motion.

HIT HOLD BEFORE RESET

This message appears during RUN mode when the operator attempts to reset the program while the axes are still in motion.

TURN ON SPINDLE TO ENABLE PROGRAM START

The operator will receive this message if he tries to execute a program with the spindle off.

ERROR opening TEMP.TXT

This message applies when "–" is selected to view the TEMP.TXT file in RUN mode. It appears when the TEMP.TXT file could not be found.

||Hit [1] to CONTINUE or [0] to EXIT

This message is displayed when "–" is selected to view the TEMP.TXT file in RUN mode and the TEMP.TXT file is too large to fit on one page. The maximum number of GCODE lines that will fit on a page is displayed and the operator is given the option to review the remainder of the file or exit.

— END OF PROGRAM || Hit any key to EXIT

This message applies when "–" is selected to view TEMP.TXT in RUN mode. It appears when the end of TEMP.TXT has been reached.

[POWER ON] FAILED

The operator receives this message when EZ-TRAK could not turn power on.

DRIVES NOT ON, FAILED TO GO HOME!

this message is displayed while attempting to home the axes with power off.

SET AXES | TIMED-OUT

This message is displayed when a SET X, Y, Z command was submitted and the BMDC timed out This could occur immediately after homing the machine or during SET X, Y, Z.

SET AXES | FAILED

This message is displayed if the BMDC failed to SET X, Y, Z.

HOMING | TIMED-OUT

This message is displayed if it took longer than 60 seconds to home all of the axes.

HOMING | FAILED: HIT KEY TO CONTINUE

This message is displayed if a BMDC failure was detected while attempting to home the axes.

ERROR opening PGM-file-name

This message is displayed when the PGM file to be loaded could not be opened. Check available memory on the C drive.

ERROR — PGM LOAD FAILED LOADING file-name

The PGM file could not be loaded because of a BMDC error.

ERROR error-number LOADING file-name

The PGM file could not be loaded because one of the following errors (listed by error number) has occurred:

1. File is too big.
2. BMDC error.
3. BMDC write error.

RADIUS MUST BE POSITIVE

A negative radius value was entered for a DO EVENT or MDI move.

ERROR opening PRGM PGM-name

The selected PGM program could not be found.

ERROR opening PRGM TEMP.TXT

No GCODE file could be found for the PGM program.

READING PGM-file-name

Notifies the operator that the selected PGM is being loaded into memory.

Nsequence-number ;SUBPRGM subprogram-name

This message notifies the operator that the selected sub-program is being loaded into memory.

ERROR opening TXT FILE TXT-file-name

This message is displayed when the selected TXT file could not be found.

MOVE Z TO FACE DEPTH

This prompt appears inside a TEMP.TXT file just before a face mill cycle. It prompts the operator to ready Z for a face mill operation.

MOVE Z UP

This message appears inside a TEMP.TXT file just after a face mill cycle. It prompts the operator to move Z up to clearance height after the facing cycle completes.

ERROR opening PSURF.LST

This file contains the point locations used by preview to draw the part. Make sure there is available program memory and available memory on the C:\ drive.

ERROR opening PGM-file-name

The PGM file to edit could not be opened. Check available memory on the C:\ drive, check that the C:\ drive can be written to, and check that sectors on the C:\ drive containing the PGM file can be written to.

ERROR opening COMP.TMP

the temporary file COMP.TMP is a storage area that will contain the cutter compensation GCODE for the second pass of a COMP | RPT block. Check that the sectors on the C:\ drive that contain COMP.TMP can be written to.

WARNING — PGM-file-name NOT SAVED

A PGM file could not be saved to the C:\ drive.

OUT OF MEMORY

This message is displayed when the machine runs out of program memory while attempting to insert a PGM line into the file being edited.

WARNING — TEXT NOT PASTED

The temporary file COPY.TMP used to hold the PGM lines to be pasted could not be opened. Check for available memory on the C:\ drive and check that the sectors on the C:\ drive containing the COPY.TMP file can be written to.

WARNING — TEXT NOT COPIED

The temporary file COPY.TMP used to hold the PGM lines to be copied could not be opened. Check for available memory on the C:\ drive and check that the sectors on the C:\ drive containing the COPY.TMP file can be written to.

| SEQNUM NOT FOUND — END OF FILE |

This message appears when GOTO N has been selected and the requested sequence number has not been found. Note that GOTO N only searches from the current cursor position to the end of the file. If you wish to find a sequence number before the cursor, move the cursor to the top of the file before selecting GOTO N.

WARNING — GEOM.LST NOT CREATED

GEOM.LST is a file containing point locations used by "VIEW PART" to draw the part. Make sure that there is available memory on the C:\ drive.

WARNING — PGM-subprogram-file-name NOT SAVED

The subprogram called by the part program does not exist.

WARNING — PGM EXISTS . . [0]=OVERWRITE

A copy of the PGM file being saved already exists on the drive to which the file is being saved.

NOTE – KEY INVALID WITH COMP ON

This message applies when a PGM program is edited or created and the line being edited or created is between COMP ON and COMP OFF. Only M LINE, M ARC, BL LIN, and BL ARC moves are allowed. This message will be displayed if any other key is pressed.

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